The Welding Engineer

Edited by L. B. Mackenzie

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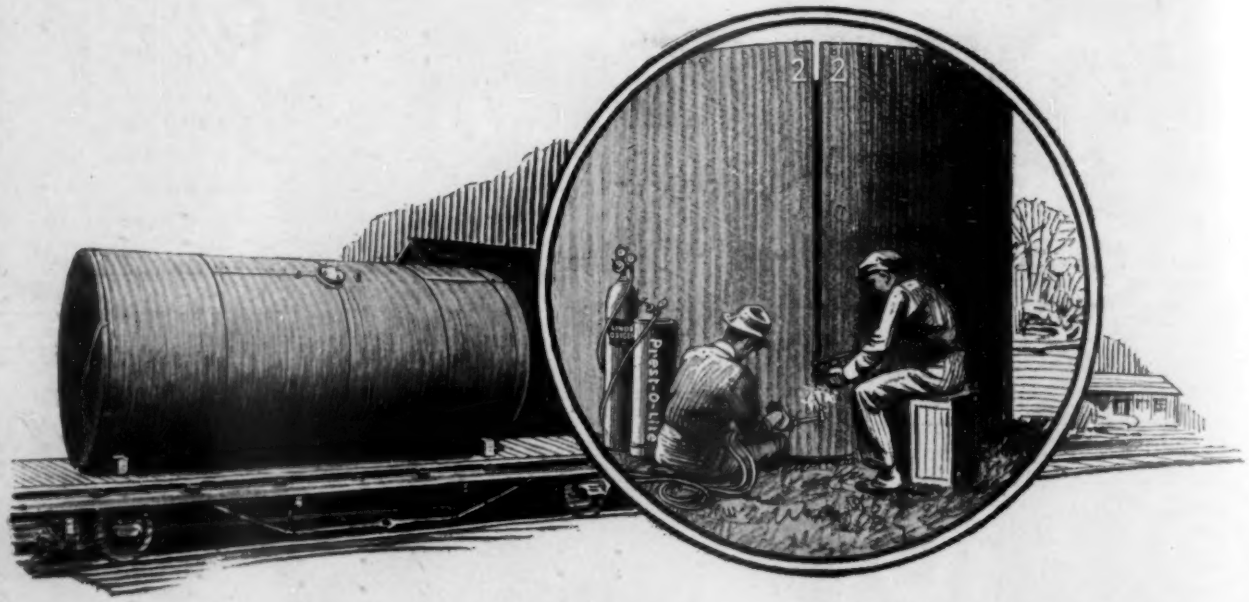

And Now—the One-Piece Storage Tank!

A leak-proof tank! Welcome words if you are interested in storing large quantities of inflammable liquids.

The oxy-acetylene process is making this an every day possibility—even in the largest of storage tanks!

The tank shown on the flat car is 15,000 gallons capacity, built entirely of ¼" tank steel plates. This container, and another still larger—a 40 footer—was welded throughout with the Oxweld torch.

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Unequalled in construction
Unsurpassed in performance

Mixture

MIXTURE is a fundamental upon which the practical usefulness of the oxy-acetylene flame depends.

Free oxygen in the flame combines with the iron and produces an oxidized weld.

Free acetylene combines with the iron and increases the carbon content of the weld.

The "feathery cone" indicates the presence of FREE ACETYLENE in the flame but unless the gases are intimately MIXED does NOT indicate the ABSENCE of FREE OXYGEN.

The TIME required for the initial stage of the combustion in the oxy-acetylene flame is one ten-thousandth part of a second. One volume of oxygen for one volume of acetylene is consumed to complete this initial reaction.

Molecular contact between the acetylene and oxygen must take place before its combustion can be complete. This is possible, in this short interval of time, only when a MIXTURE of molecular contact thoroughness is obtained before the gases reach the point of combustion.

TIME is ESSENTIAL and turbulence is beneficial in producing an intimate mixture of gases.

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(To be Continued)

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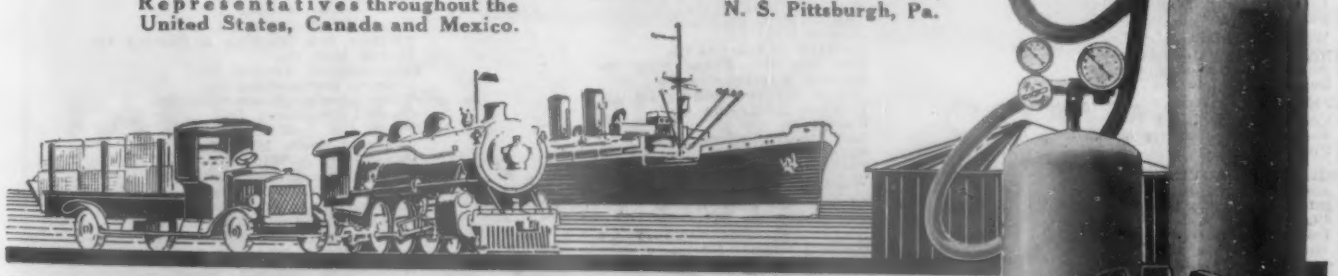

WELDING PUROX CUTTING

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Conform in all respects to A. W. S. specifications.

Look for red tag and red-colored ends.

Hardness Analysis

(Scleroscope)

1	(Original Metal)	30
2		31
3		31
4		32
5		33
6		35
7		37

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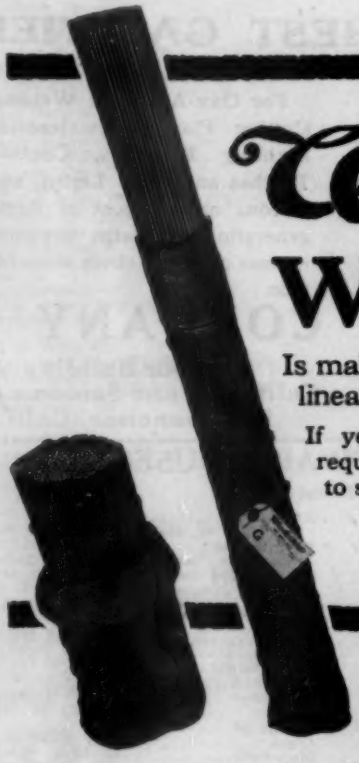

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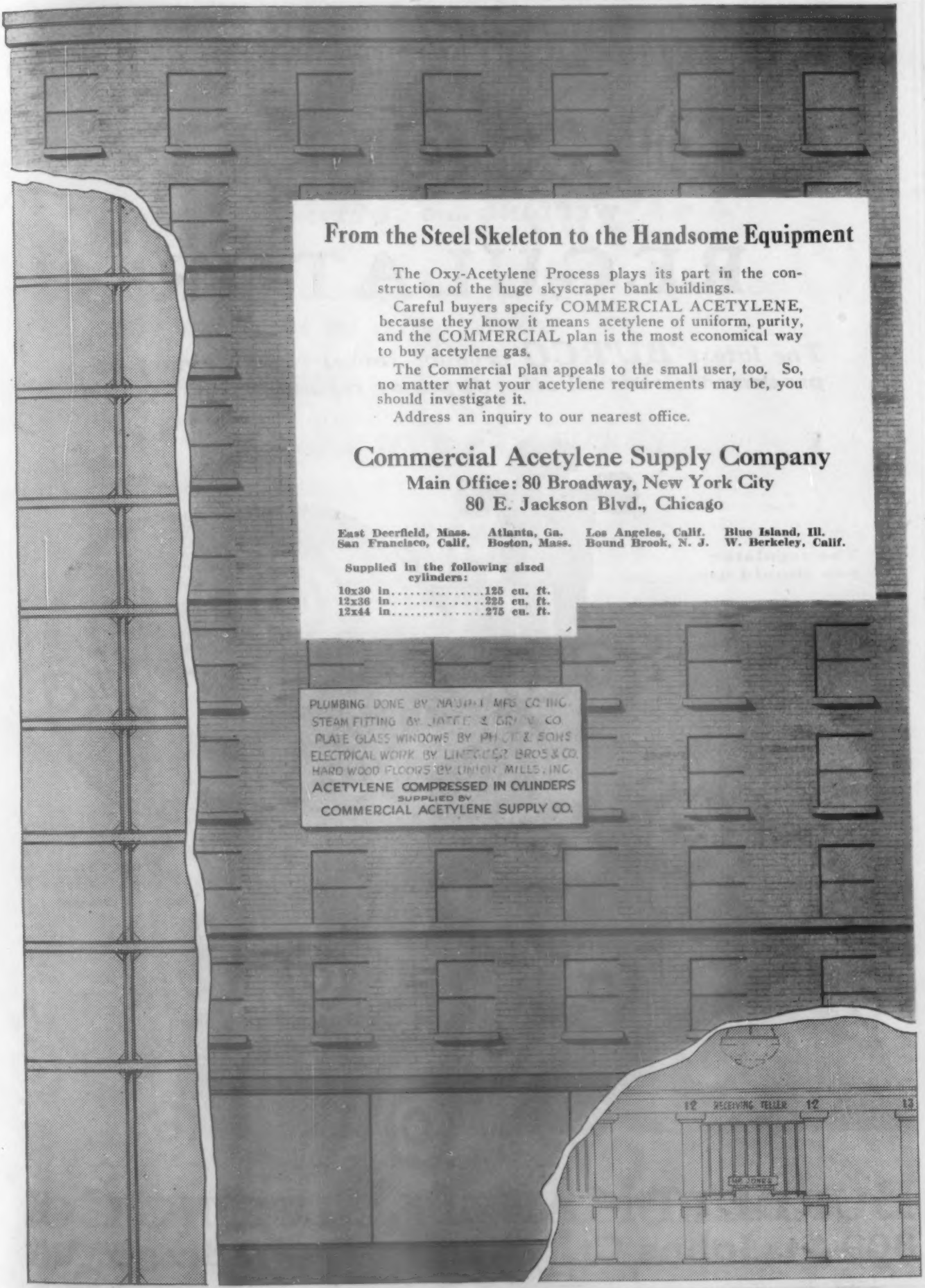
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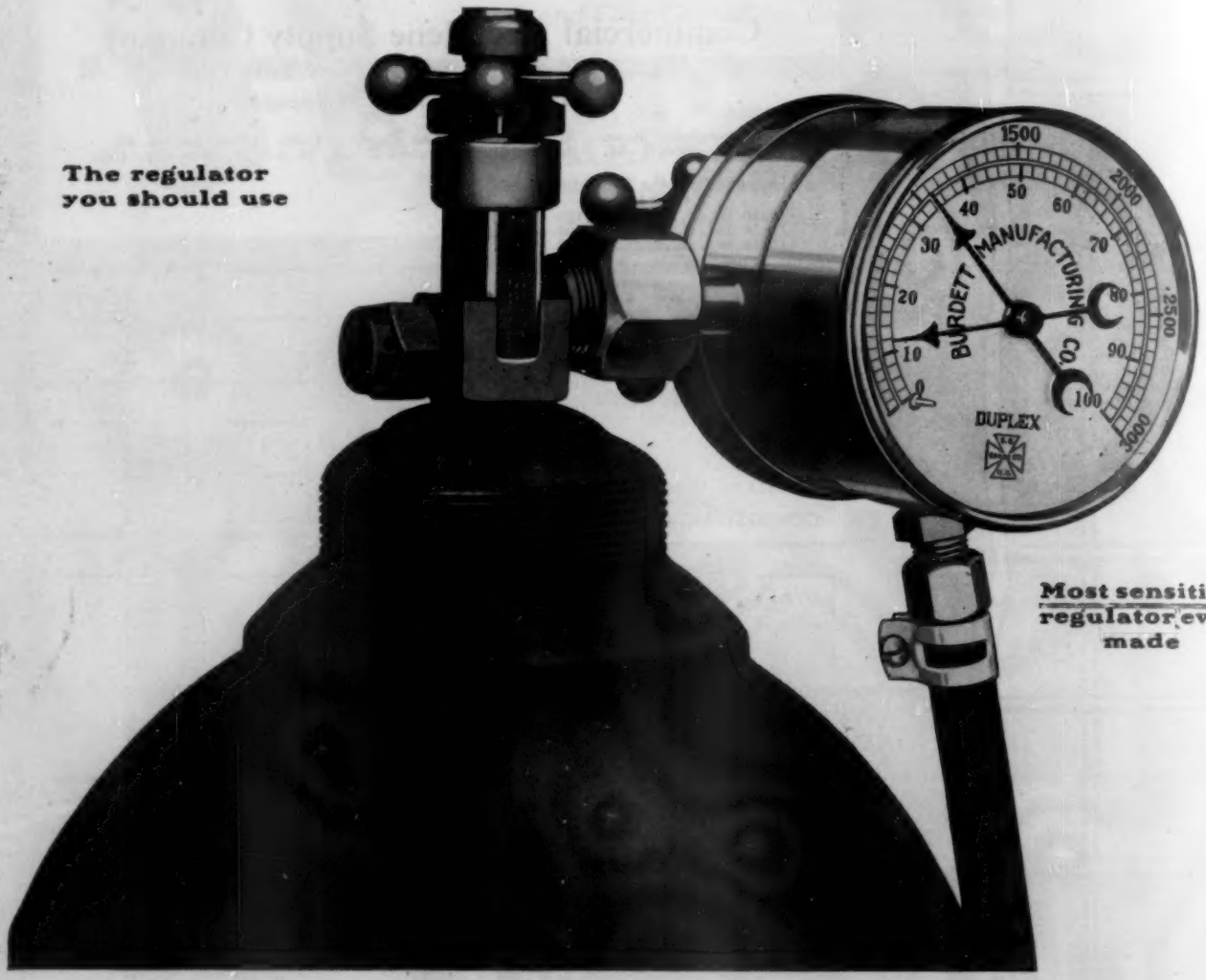

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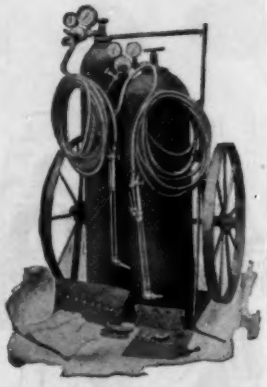

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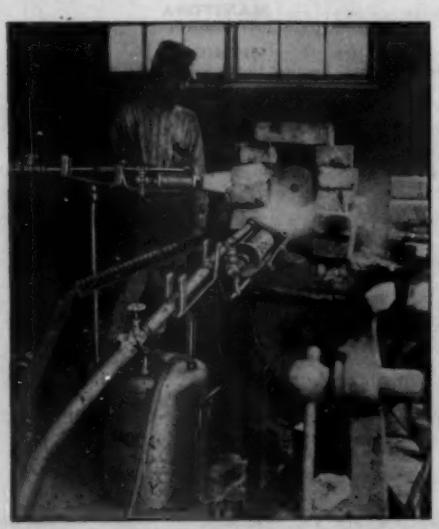

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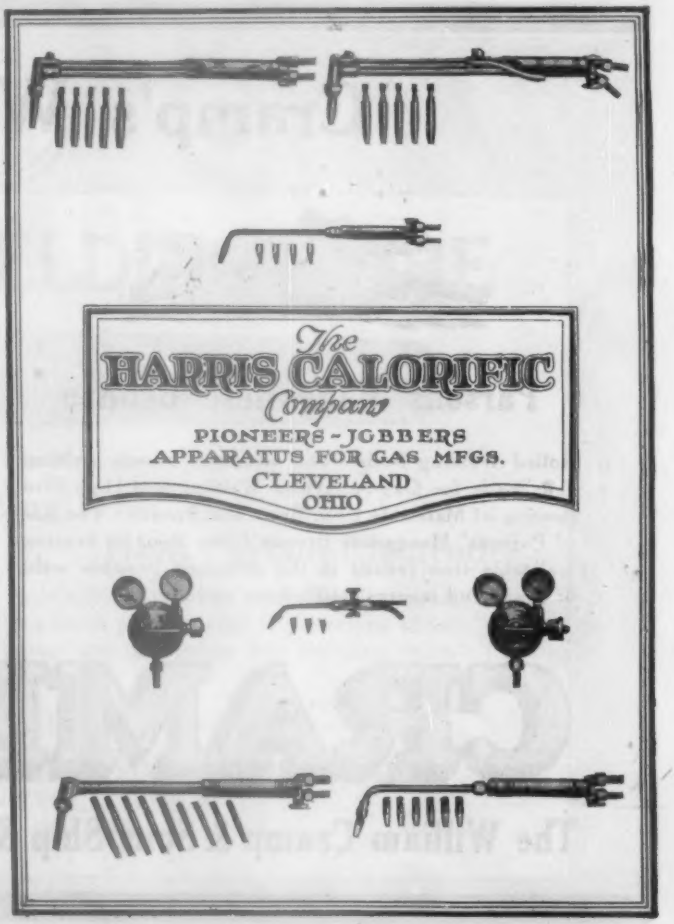

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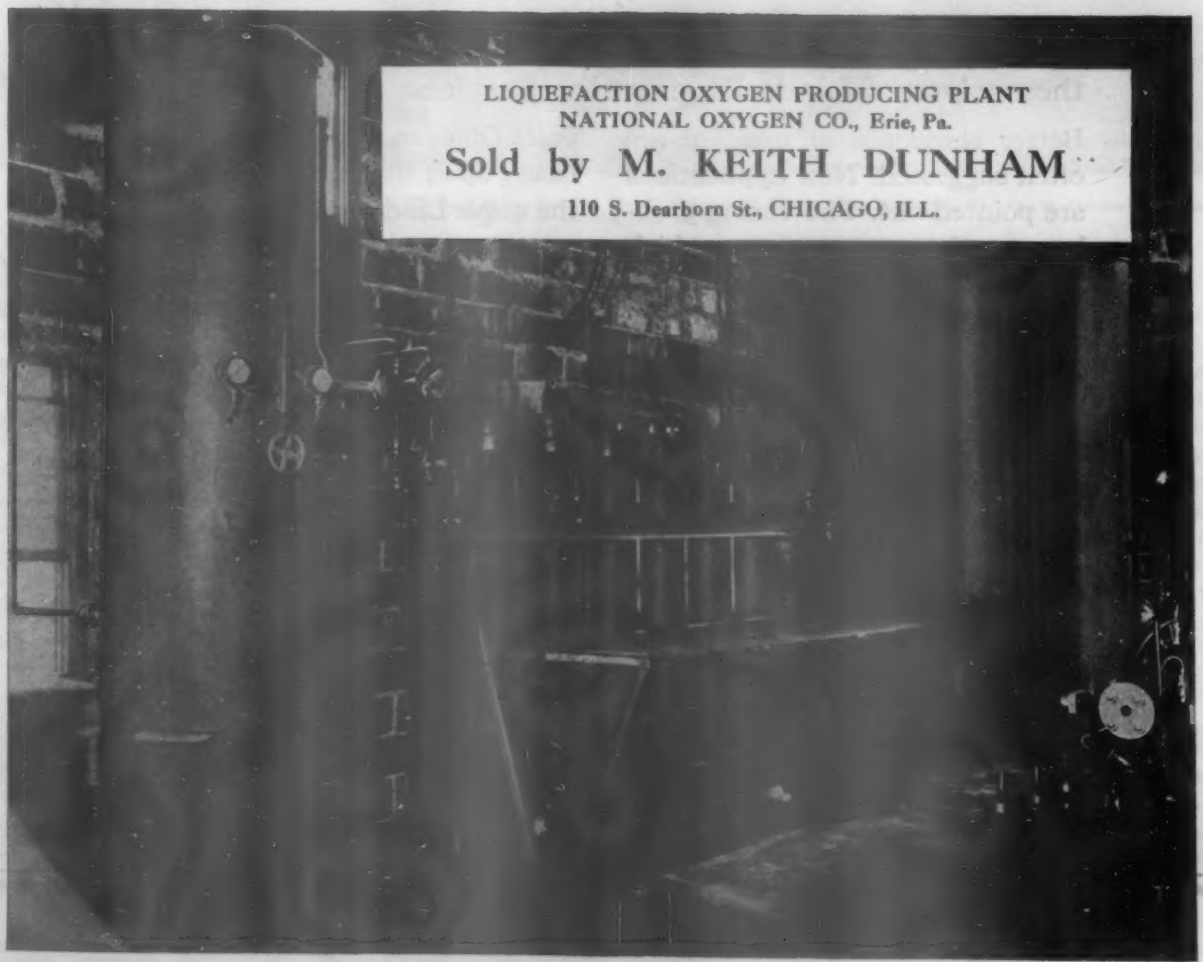

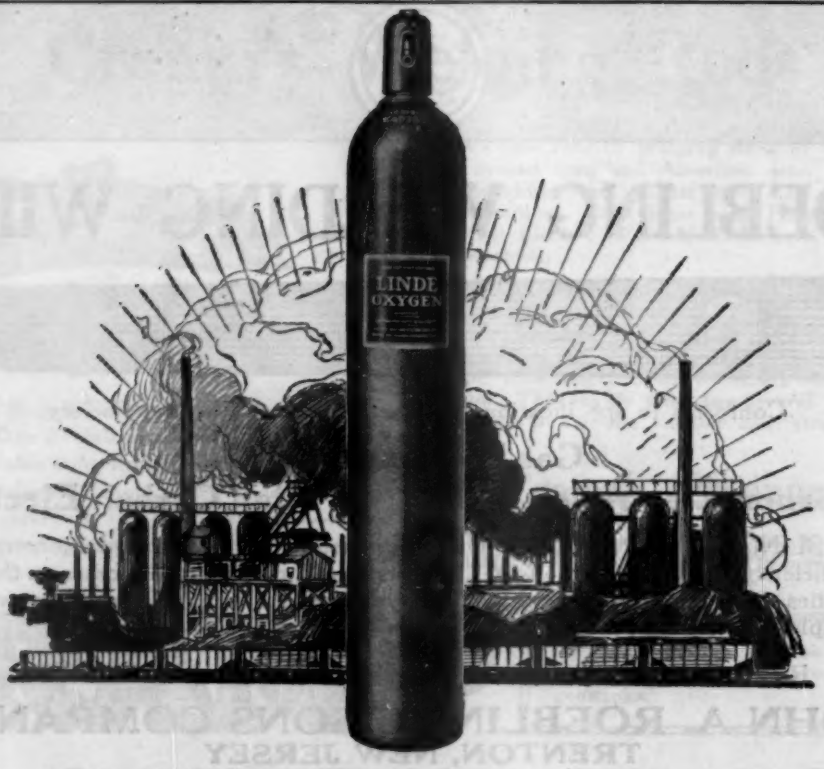

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LINDE OXYGEN

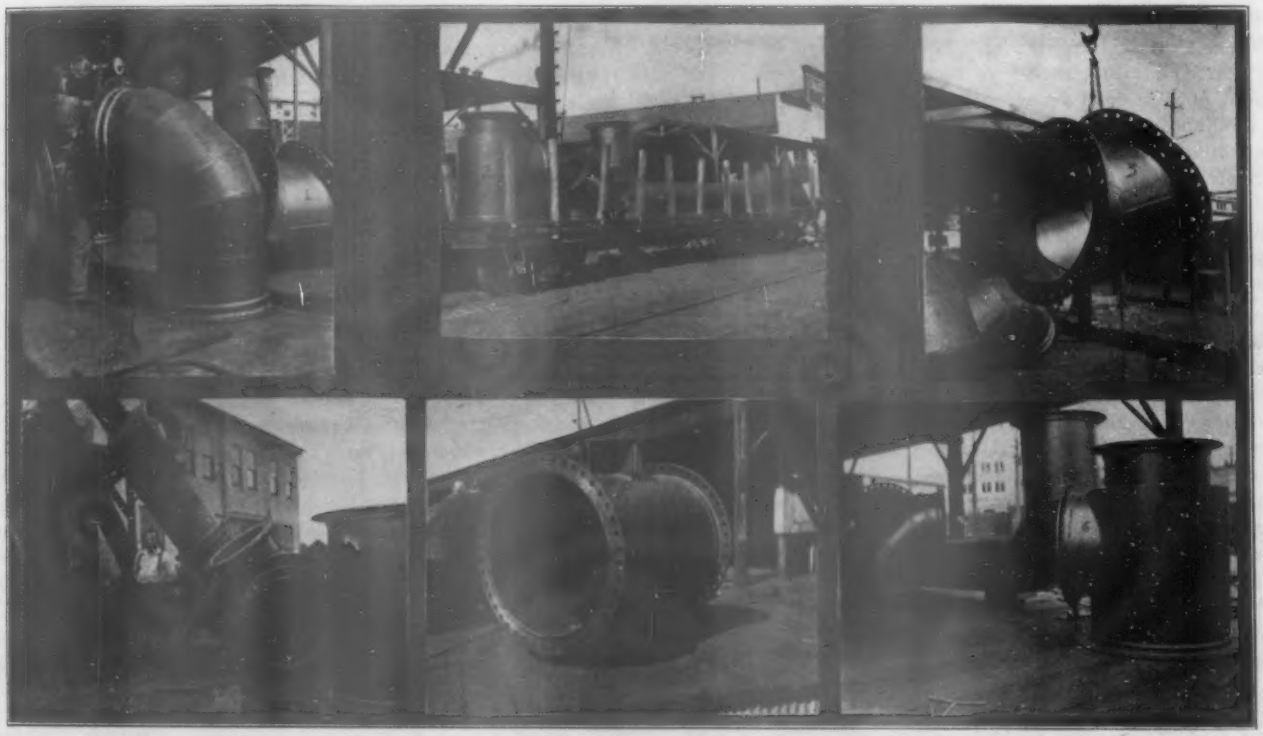
WELDING PIPES and FITTINGS

Usefulness of Welding to Electric Companies—Efficiency of Welded Joints—Economy of This Method

WELDING engineers in the far west are constantly finding new applications for the welding processes in large industrial plants. The oil fields, mines, shipyards and lumbering camps supply some of the best fields for further applications. The public utility companies have, in many cases, found uses for large installations of welding equipment, particularly the gas companies in connection with their work of laying gas mains. The Coast Culvert & Flume Co., Portland, Oregon, recently completed some interesting work for the Northwestern Electric Co. of Portland which will serve to demonstrate the usefulness of welding to the electric companies. This work consisted of welding the pipe and fittings for the circulating water system for the condensor of the new plant of the Northwestern Electric Co. at the Foot of Lincoln St., Portland. The pipe sizes run from 28″ to 48″ in diameter, and are made from metal from 5/16″ to 3/8″ thick. In the past cast iron has been used exclusively for this class of work, so this is the first trial the electric companies have made with welded pipe and fittings. The construction shown in the illustrations, including the flanges on the end of the fittings are manufactured complete by arc welding in the plants of the Coast Culvert & Fume Co.

The engineers of the electric company have been watching the work of welding these fittings for the new steam plant as it went through the welding shop, and have expressed themselves as being very much pleased with its appearance, at the same time conceding that the investment and service in this class of construction will be much more economical than the type of construction formerly used for this class of work.

An examination of the photographs of some of the welds will indicate that the welding itself on this work does not present any unusual difficulties. The designs are fairly simple, and the assembly can easily be performed by a first class welder. The adoption of this type of construction by other companies is only a matter of convincing the engineers that the arc welded joint is fully as efficient as the old-fashioned type of fittings, with the added advantage of being much lower in cost, and promising a longer and better service. Illustration No. 1 shows a 28″ electric are welded elbow made from 5/16″ plate, with plate steel flanges made from 1/2″ plate. Illustration No. 2 shows tees, ells and intake made from 3/8″ plate, and electric arc welded throughout. A 36″ ell made from 5/16″ plate, with 1/4″ plate steel flanges is shown in illustration No. 3.



Different Types of Arc Welded Elbows, Pipes and Fittings Made by The Coast Culvert & Flume Co., Portland, Oregon, in Connection With Their Work of Laying Gas Mains.

The ease of making joints in stock of different thicknesses with the electric arc is indicated in the other pictures. Illustration No. 4 shows four different special fittings from 3/8″ and 5/16″ steel with the flanges made of plate steel 1/2″ and 1/4″ thick. Illustration No. 5 shows a 48″ by 28″ electric arc welded tee with a built up base, and with special 1/4″ plate steel flanges. The tee is made from 3/8″ steel plate, and the base from 3/4″ steel plate. Illustration No. 6 shows a 48″ intake 18″ long and a 48″ tee and elbow made from 3/8″ plate steel. The fittings are provided with flanges from 1/2″ and 1/4″ plates. Comparison of these illustrations with examples of some fittings made of cast iron will show that great economies are effected both in the cost of the original material and the expense of installation. It has also been found in practice that the welded joints greatly reduce the possibility of leakage, and when these constructions show signs of wear, it is far easier to make a replacement in a welded line than it is where the old type of cast iron fittings are used. It is also easier to make changes in the installation by welding in new special fittings.

WELDING IN PETROLEUM INDUSTRY

Selection of Welders—Material Used—Welding Applications in this Field Are Extensive and Ever Increasing

By K. V. King†

AUTOGENOUS welding has become a necessity to the Petroleum Industry. Welding has reached its present value in practically every branch of the oil industry only through a long period of development in which step by step it has been found and proven to offer a means of construction which usually results in greater economy, which enables the construction of equipment that oftentimes could not otherwise be built and which above all gives increased safety of operation.

Welding with the Standard Oil Company of California first started in 1911, and since then has steadily increased in amount until in 1920 an average of 148 acetylene and electric welders and helpers were employed by the Company with a maximum for that year of 290 in August. From January to September 1922, inclusive, there has been an average of 132 with a maximum of 189 in August. The greater number employed in 1920 was due to an unusual amount of construction work. However, the uses to which welding is being adapted are continually increasing.

In discussing welding practice, the first consideration should be the welders themselves. One of the principal objections raised against fusion welding processes is that the quality of welds depends largely upon the ability of the welder. We realize and recognize this and have tried to meet it by the selection and instruction of the welders and by continual watch over the work. When hiring welders from the outside, we assume that they know their trade but give each one a test or tryout to see if he meets our standard. This tryout consists of making a "V" weld in 5/8-inch or 3/4-inch plate lying flat and vertical and in welding 6-inch pipe held stationary, thus requiring overhead welding. This test, of course, is not severe but is sufficient for our foremen to judge the applicant's ability. During the last year only 40 per cent of those who tried out have met our standard and when employed they are placed on welding that is not subjected to high pressure or high temperature. Their welding is observed and they are instructed in our methods. Those who demonstrate sufficient ability are placed on high pressure work. Such a tryout is of particular advantage to men seeking employment as well as to the Company. It is recognized that commonly tradesmen are better qualified in some particular branches of their trade than in others and that by such tryout their ability is immediately demonstrated. When employed their future is less in doubt as they have assurance that they should be able to give satisfaction.

The material to be used in welded construction should be the next consideration. It is very desirable to use low carbon steel since it is not as susceptible to over-heating, burning or oxidation and there is not the sudden difference in physical properties between the weld and the plate. It is well to make a distinction here between overheating and burning. A weld or any steel which has been overheated will have a coarse grain structure and be somewhat brittle. It can be restored, however, to a satisfactory condition by heat treatment. On the other hand metal that is burnt cannot be restored by any heat treatment or mechanical work. This is true because there has been an actual formation of scale or oxide around the crystal boundries of burnt steel. In addition to being low in carbon, the steel should be low in impurities.

Referring especially to containers used in oil refining processes special welding grade, firebox or flange plate, depending upon the purpose, is used for our welded construction, and precautions are taken that pipe used in particular services is open hearth steel. A thorough investigation is under way covering the use of alloy steels in vessels particularly when subjected to high temperature. The use of these metals will not be undertaken until every possible factor has been taken into consideration.

The ripple weld is used on steel plate under 1/2-inch thickness. For material heavier than 1/2 inch, particularly when subjected to pressure and temperature, we hammer the weld while the temperature of the metal is within the critical range. Since the weld is originally a cast structure, hammering, which is in the nature of a forging operation, produces a finer grained structure and a metal that is more resistant to vibratory loading. Care is taken to stop the hammering at a temperature where the color is about a cherry red for below this temperature it does no good and may cause injury by setting up cold strains in the metal. Particular care should be taken to avoid setting up cold strains in metal that is to be subjected to operating temperatures above about 800° F. as grain growth may result.

It is our practice to anneal all acetylene welds. There is a question as to the necessity of doing this, raised particularly by some of those doing commercial work. There seems to be no doubt, however, as to its desirability. Our attitude is that we want the best construction we know how to obtain. Considerable experimental work on various methods of annealing has been done. Small portable furnaces heated by an oil torch, to encircle a weld in 6-inch to 12-inch pipe have been built but difficulty has experienced in maintaining a lining. The method now used is to reheat the weld with the acetylene torch using a large flame. Pipe bends with welds in them are placed in a large furnace and the entire bend annealed. Pyrometers are installed in all our flanging and heat treating furnaces. When annealing with the torch the weld and the metal adjoining are heated to a temperature of probably a little over 1600°F., or a salmon color, and allowed to cool slowly. This is done for the purpose of (first) relieving the welding strain, (second) annealing the weld metal to reduce the grain size and make it more ductile, and (third) to remove any coarseness of grain in the base metal adjoining the weld. It is realized that the annealing temperature of the deposited metal is higher than that of the base metal, but it is thought that the beneficial effects of refining the deposited metal are greater than the harm that might result from the possibility of overheating the base metal. It has been found that annealed welds consistently show greater elongation over the welded area when tested and they may be bent through a greater angle than when unannealed.

For our usual or routing tests in the welding shop we do not have tensile specimens made but merely bend the welds in a press. One edge of the weld is often ground smooth and etched with ammonium persulfate solution.* This solution is much more effective in developing structure visible to the naked eye than is nitric acid solution which is commonly used. It is interesting to note that electric welds which have been improperly fused into the base metal will be clearly indicated by this etching. Our bend tests are not confined to specimens purposely made for testing, but after

†*Metallurgist, Standard Oil Company of California.*

**Abstract of paper read before American Welding Society, San Francisco Section, Engineers' Club, San Francisco, Cal., October 20, 1922.*

*This solution is fully discussed in Scientific Paper No. 420, of the Bureau of Standards.

every piece of large construction work the Shop Foreman will promiscuously mark out places on the welds to be cut out and bent. This serves as a check upon the type of work going into structures, and in addition it has a desirable effect on the morale of the welders. They know the quality of work required and they know they will have to produce it. It has been gratifying to find that all such specimens cut from actual work have always indicated high quality welding and we thus know that our method of control and supervision is giving us the results that we want. There is no doubt that the standard of our work is continually improving. One of the changes in the last year is that all welding on pressure containers is stamped by the welder with his identifying number so that there is a record of which welder has made each part of the work. Thus it is possible to place the responsibility for good or bad welding.

The study of welds and castings by X-Ray examinations has been considered, but after going into the subject somewhat it was decided that there is apparently little practical application in its present state of development. Magnetic testing has been considered and seems to offer possibilities of development to a state where it may be successfully used.

The applications of welding made in the Petroleum Industry are very extensive and ever increasing and extend to practically every branch of the industry. When oil first comes out of the ground it must as a rule be passed through "gas traps" to separate out any gas that it may carry. These traps used to be constructed with threaded connections but are now built by welding which offers a much cheaper, quicker and more reliable method of construction. A large part of the gas production in the oil fields carries a considerable volume of gasoline much of which can be recovered by passing the gas through compressors and then cooling it in a spray tower. Many of the plants for accomplishing this have a capacity for handling millions of cubic feet of gas per day and the coils in which this gas is precooled, intercooled and after cooled utilize miles of pipe. If these coils were all made up with screwed joints and manifolds they would be very costly and probably subject to serious leakage. By the use of welding they can be made very compact and are practically free from leakage. Welding is also used extensively in gas absorption equipment. In pipe line transportation welding has become practically standard in the construction of gas lines. Welding has only recently been applied to the construction of oil lines but it promises to make an equally favorable showing in this important phase of the petroleum business. Acetylene welding has almost become a standard in the construction of pump house manifolds.

It is of course at the refineries that welding is finding its greatest fields of usefulness. Electric welding is used more in the refineries than in the field and the applications for it have gradually increased until at present a third to a half as many electric as acetylene welders are employed. This proportion, however, varies as the character of the work to be done changes.

Acetylene welding of pipe lines that are subjected to high pressure of hot oil is good practice. This is desirable as it reduces leakage and presents a joint about twice as strong mechanically as a threaded connection.

This mechanical strength is necessary as proper precautions as not always taken for expansion stresses and failures in screwed connections may result. Welded manifolds are particularly desirable as it is sometimes very difficult to hold light lubricating oils with screwed fittings.

Welding has been useful on structural work for clay elevators, spouts, hoppers, chutes and dryers and for large filters and storage pans in the lubricating oil plants.

Experience has shown that electric welding of riveted crude stills on the bottom inside caulked seams and around the rivets will make enormous savings in repairs. Without the welding, the lap on the bottom sheets buckles up and coke is deposited which produces leaks and makes further caulking difficult.

It has been found that electric welding may be successfully used for repairs to tank bottoms, the patches whether large or small being laid on the bottom and electric welded. This may be economically used for completely renewing bottoms in large tanks as the necessity for raising the shell is thus obviated. Roofs on the new tanks may be electric welded instead of riveted, thus making the roof tight and possibly making the construction more economical.

In boiler houses welding may be used extensively. Acetylene welding of steam manifolds or headers is a satisfactory method of construction and eliminates more or less continual leaks on screwed connections. Reinforcing of caulking edges of the heads of return tubular boilers by electric welding has been found satisfactory. This will reduce repairs enormously. Reinforcement of flue holes by building up with electric welding and then reaming out has saved flue sheets that would otherwise have to be removed and scrapped. The welding of the beading on the tubes on the combustion end of the boilers will materially reduce the leaks.

An experimental laboratory of an oil company is really a miniature refinery, and welding has been found to be far the most desirable method of construction of such small apparatus.

In an asphalt plant acetylene welding has been found to be suitable for making vapor lines and expansion joints, steam jacketed asphalt headers, and steam jacket manifold nozzles for filling barrels.

In pressure still construction, acetylene welding may be used extensively to advantage, and in many places it has been found that such construction is not possible without welding, and furthermore, it is the only safe method. Experience has proven that with the use of qualified welders, high class material and close supervision, acetylene welding may be successfully used on vessels with ½-inch, ¾-inch, ⅞-inch up to 1-inch shell thickness that subsequently will be operated under pressure and at a high temperature.

Welding has been used for the repair of steel castings that, due to their design and the requirement of prompt delivery, presented difficulties to the foundry.

The Petroleum Industry calls for but little cast iron welding with the exception of some repair work. There is also but little use for aluminum welding. There is, however, considerable brazing done, largely on repairing iron barrels.

Realizing the importance of welding and the desirability of using the highest quality methods and practices throughout the entire company the Engineering Department, together with those experienced in welding, compiled in 1921 what was termed a Welding Manual. This covered the conventional, established, general information applicable to and of specific value to our own particular work. It was circularized to those in authority over welding throughout the Company and has served a good purpose. It covered in part safety regulations for you must realize that welding in the oil industry must be done with unusual precautions. Some of these are that a fire permit signed by three designated persons in authority must be obtained before welding is done on refinery equipment, that a welder must always have with him a fire extinguisher when working within certain boundries, and that all equipment which has contained oil must be thoroughly steamed and have steam flowing through it while welding is being done.

This has given a general idea of the extensiveness of the use and the importance of autogenous welding in the Petroleum Industry. Autogenous welding has been successfully applied for these many purposes as we can truthfully say.

GENERATOR WITHSTANDS FIRE

Acetylene Generators Are Not Dangerous—Properly Constructed Automatic Generators Do Not Explode and Cause Fires

By B. K. Smith

THOUGH no one can deny or discount the convenience and saving effected by having an acetylene generator in one's shop, there are those who refuse to purchase such equipment on the ground that they are unsafe, and mean an additional fire risk. To these skeptics I can only say, "An acetylene generator is as safe as it is simple."

The automobile, airplane, locomotive, or any other mechanical contrivances designed and fabricated by human hands are not 100 per cent perfect. Though an automobile skids into a curb, the airplane crumples and falls, or the locomotive boiler explodes, no reasonable person would consider these mechanical contrivances unsafe or dangerous.

An acetylene generator, when properly constructed and the directions of the manufacturer as to use are followed, is every whit as safe as the auto, airplane, or locomotive. Yet the general impression has prevailed among a certain class of welders that generators are dangerous articles to have on one's premises. This feeling has been strengthened by the fact that the fire insurance companies and city councils have placed restrictions on the use of generators within certain zones.

However, men familiar with the industry seldom hear of a generator explosion. What we do hear, however, is that some home-made generator, minus the common safety devices found on all standard generators, popped off and headed for the heavens, through the roof. Even in such cases, the shop owner merely has to patch a hole in the roof, brush the lime residue from the walls, repair broken windows, and he is again ready for work.

When fires in welding shops are investigated and the real causes determined, it is usually found that the conflagrations were due to defective or leaky hose, connections, or valves, or else to the carelessness of employes. Fires of such origin will occur in welding shops whether its owner uses a generator, or purchases acetylene compressed in cylinders.

The writer has been through fires in which the welding shops were practically destroyed. Each shop had and was using an acetylene generator, and in no case was the blame laid on the generator. As a matter of fact, while everything else in the shop was consumed by the flames, the generator remained intact. It did not explode; it did not cause the fire; and the only damage done to the generator was that the spring in the motor feed device was destroyed or annealed. A new spring and a little painting was sufficient to place the generator in O. K. condition.

Figure 2—View of Southern Garage and Welding Works, Showing the Uninjured Acetylene Generator and the Remains of an Auto Destroyed by Fire, Due to Its Supply of Gasoline and Oil.

Fig. 1 shows the remains of the Southern Garage & Welding Works, Breckenridge, Texas, recently destroyed by fire. While everything else in the shop was destroyed by the flames, the acetylene generator remained intact and uninjured. Fig. 2 is another view of the same shop with an acetylene generator and the remains of an auto. Carbide alone will not burn; neither will water, and whatever acetylene the generator contained, escaped through the pop off or safety valve, or remained in the welded generator without doing any damage. Study the photo and then decide whether the generator or the auto loaded with gas and oil is the most dangerous.

But skeptical readers ask the meaning of "properly constructed generators." The writer does not desire to emphasize or recommend any particular make of generator, but in his opinion the most desirable generator is one that generates acetylene auto-

matically. This means that the acetylene is produced as it is consumed. A generator which does not work automatically will generate an excess or an insufficient amount of acetylene. Excess gas raises the pressure in the generator. This excess then escapes through the safety valve and is wasted. Insufficient gas is deterimental to welding, as it lowers the amount of acetylene being burned at the torch tip, and causes the flame to change from a neutral to an oxidizing one.

In addition to being so constructed that it generates gas automatically, a generator must have a sufficient water content to prevent overheating. When carbide is dropped or kicked into a tank of water, it will boil and thus heat the water. For instance, when 1 pound of carbide is dropped into 1 gallon of water, it will dissolve, forming acetylene gas and lime. This chemical action will liberate latent heat, raising the temperature of the water considerably. There is no way of controlling the heat liberated by the union of carbide and water, but the temperature

Figure 1—The Remains of the Southern Garage and Welding Works, Breckenridge, Texas, Recently Destroyed by Fire. Only the Acetylene Generator Remained Intact and Uninjured.

of the mass can be influenced and controlled by an excess of water. For this reason 1 gallon of water to 1 pound of carbide has been adopted as a standard measure by generator manufacturers.

Therefore, if one uses a standard automatic feed device on a generator, uses 1 gallon of water for every pound of carbide, and changes the water with its lime residue when adding a new charge of carbide, he will have and maintain a good and safe acetylene generator. There should be, of course, other safety devices, on an acetylene generator, such as a suitable blow-off valve and a vent pipe coupled to it; a flash-back tank which should be kept with water up to the water line; and a large and sensitive gauge, so one can see its numerals.

The writer, a few years ago, sold a generator to a large blacksmith shop at San Marcos, Texas. The owner insisted that I give him some credit on his old home-made generator. This old generator had blown up several times and each time it returned from its aerial flight, our mister blacksmith had it repaired and placed in use again. One can still see several patches on his roof where his old home-made generator travelled through. He purchased a new generator because he was tired of the roofing business and desired a dependable and safe source of acetylene gas. This new generator has rendered extremely satisfactory and efficient service and has given no indication that it desires to ramble heavenward through the rafters.

When home-made generators are used and an explosion occurs, news of the accident is, of course, immediately broadcasted far and wide, and although a generator is practically indispensable if the welding shop is to operate at a profit, welders fear to purchase them. Not until these folks wake up and realize that an automatic acetylene generator is just as safe as it is simple and positive in action, will they begin to make the profits they should realize from this work.

OLD ACETYLENE CYLINDERS

Note: The trouble with dangerous materials is that they may often be handled by the wrong people. With this in mind we reproduce here comment on a method of salvaging acetylene tanks, written by an engineer engaged in fire and accident prevention research.—Editor.

"On Page 33 of the August issue of the *Welding Engineer*, under "Hints for the Welder" appears an article entitled "Smoke Stack Mode of Old Cylinders,' in which practices are suggested that in the writer's humble opinion are open to very serious criticism; in fact we find it difficult properly to express ourselves in terms sufficiently strong to meet the needs of the case.

"Starting out with old acetylene lighting cylinders that have been junked by the railroad company, the author of the "Hint" would lead your readers to believe that it is a safe practice to build a big wood fire around a tank that may be in a most dilapidated condition and with regard to the interior of which nothing is known—here is the first point where words fail us.

"The author then proceeds to suggest the use of dynamite for loosening up the asbestos filler material, and follows with a naive suggestion that such old tank cylinders subjected to fire and the force of dynamite will make a very good compressed air tank. In the case of failure of such tank we wonder just what would be blamed, would it be the welding or the workmanship—or perhaps something else?

"We sincerely hope that such 'very good compressed air tanks' may never be used where their most certain failure will involve the loss of many innocent lives."

ANNUAL SAFETY CONGRESS NEXT MONTH

The Twelfth Annual Safety Congress of the National Safety Council will be held in the Statler Hotel, Buffalo, N. Y., during the week of October 1st to 5th. The general sessions and the section sessions cover practically every possible angle of safety in the industry. One of the papers which has particular interest to welders will be read at the first session of the Petroleum Section, Tuesday morning, October 2nd, which is entitled "Acetylene Welding and Safety in Oil Plants." The author is Mr. Timm, Safety Inspector of the Standard Oil Co. of New Jersey.

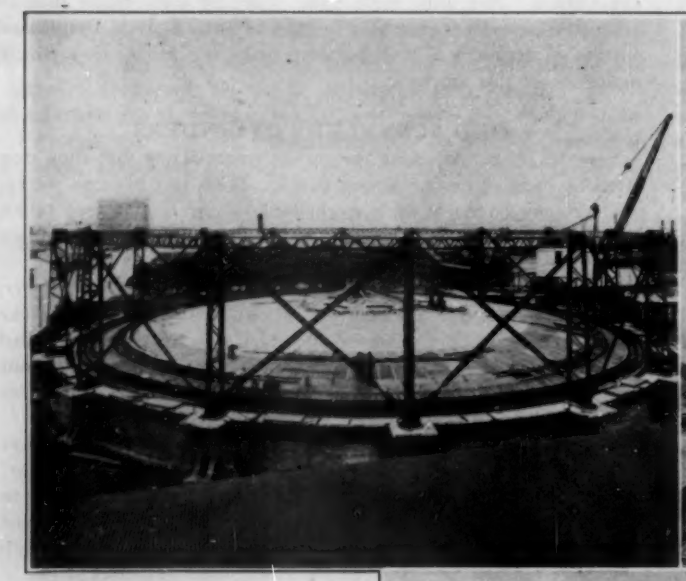
WELDING MAKES PROGRESS IN CHINA

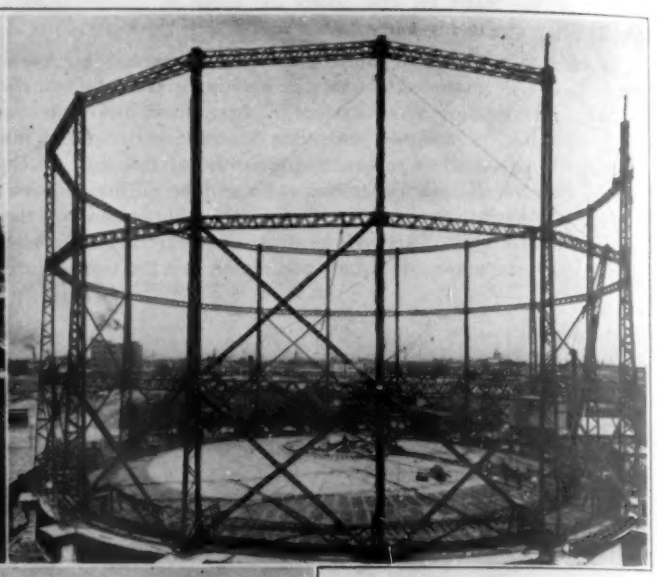
The current bulletins of the China Oxy-Acetylene & Welding Works, Shanghai, China, tells how that concern has grown in four years' time from the smallest to one of the largest best equipped welding shops in the far east. This shop has now four portable welding sets, and three portable oxy-acetylene welding plants in constant service. Their bulletin gives descriptions of their apparatus, and many photographs of the good work they are doing for the large enterprises in China. They have been consistent advertisers, and have circularized their prospective customers frequently with an interesting bulletin, giving a wealth of information on the nature of the different welding processes, and showing how these processes can be used to advantage in a great variety of repair and production jobs.

The Groen Mfg. Co. of Chicago, Ill., have recently entered the gas industry for the distribution of an imported air liquefaction oxygen producing plant.

GAS HOLDERS WITHOUT RIVETS

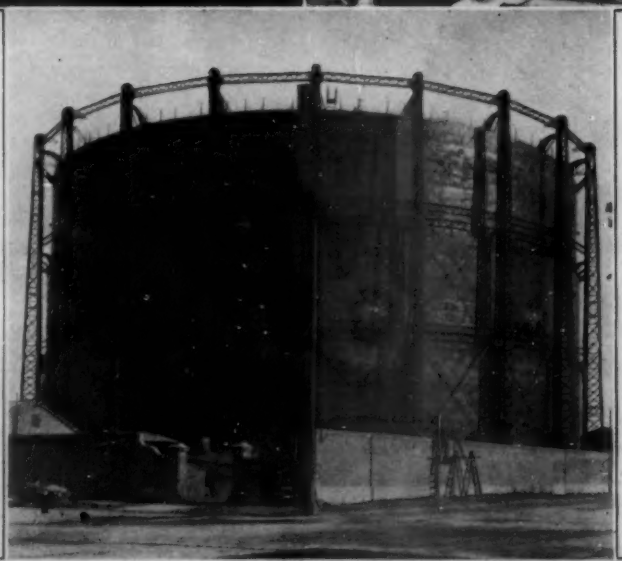
Described in Detail on Opposite Page





Above — New South Melbourne holder, showing lifts completed within tank and part of the crown welded. The first bay of the guide framing is shown erected. The gantry crane shown was constructed in the company's shops and used through the job

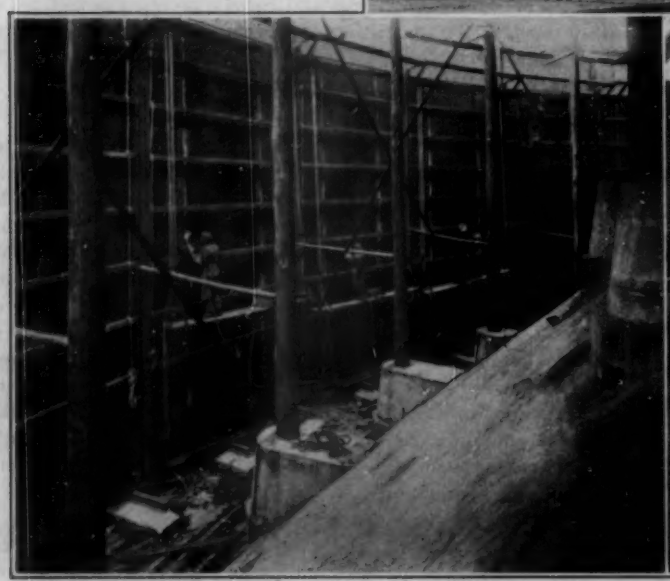
Below—Showing welding of the sheeting. Temporary timber bracing is used to force the sheeting with the circular frame during welding



Above—Completing the third bay. Note the welded guide carriages

Left—The completed holder at South Melbourne, the lifts and crowns constructed by arc-welding. This is the first known arc-welded gasholder

Below—Showing the crown sheeting. Note small number of "tack-bolts"

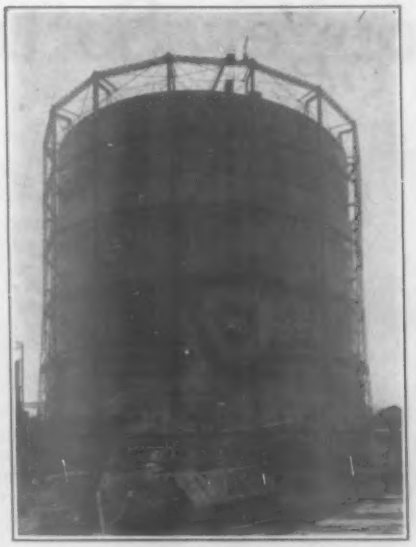


ARC WELDING GAS HOLDERS*

Advantages of New Method of Construction—Description of New Gas Holder—Extension Wall Has Novel Design

By Joseph Newell Reesom, M. Inst. C. E.

WHILE confining my remarks necessarily to the structures which have been fabricated with welded joints as against riveted ones in Melbourne, with which my name has been associated, I think I may safely say that, as far as gasholders are concerned, those erected in Melbourne are not only the first structures so fabricated in Australia, but also in the world. Let me say at once that in my opinion the advantages of the new method of construction are so great that in a few years' time no structure of any kind in future will be found to be riveted.



The welded holder at Fitzroy

The question of welding as against riveting joints, whether of sections, plates or sheets in any position, may be said to have been first considered by me some six or seven years ago; for it may be mentioned, en passant, that during the past nine years no fewer than six gasholders ranging from 500,000 cu. ft. to 3,000,000 cu. ft. have been either constructed wholly or reconstructed in Melbourne. This work, although large in itself, was performed principally during the time the World War was in progress; and, although efforts were made to induce European firms to tender, it was found that none were able to undertake the work. To accomplish this, then, in Australia by outside engineering firms was impossible; and thus it came to pass that this company, the Metropolitan of Melbourne, had perforce to undertake the work of construction themselves. Extensive fitting and constructional workshops had to be erected, tools provided, and skilled workmen and a highly efficient draughting staff trained from material which had probably no knowledge of gasholder construction previously. The first experiments in welding were confined to the jointing of sheets; as it was early appreciated that the single riveted joint ordinarily employed was lamentably weak; and numerous tests were made which demonstrated this and other serious disadvantages. For some time oxy-acetylene welding was employed, but was ultimately discarded as unsuitable, largely owing to the difficulty of overhead welding; as for instance, the under side joints of the crown sheets. Attention was then directed to the use of electric welding and numerous experiments—some 250—were made to test various types of joints and electrodes; and ultimately that employed was what is known as the "quasi arc" process. From the tests, the tensile stress of the joints made was invariably found to be equal to, if not greater than, the sheets themselves. There were few operators available; and those, who professed knowledge of welding, were not always suitable; and ultimately the training of the welders themselves had to be undertaken by the company's own staff. At the present time there are twenty-three expert welders operating, and these men have bcome exceedingly expert. Their work is examined by two foremen, also trained by the company.

Paper read at sixteenth annual convention, Canadian Gas Association, held at Ottawa, August 23-25. Illustrations by courtesy of Gas Age-Record.

The first holders built were with riveted joints; and it was not until 1920, when the collapse of a 3,000,000 cu. ft. gasholder at the South Melbourne Works took place on April 4, 1920, that the author decided to employ welding in the sheet jointing.

The collapse of this holder showed that the riveted joint was lamentably lacking in strength, and a short description may be of interest here. The holder was contained in a brick tank 200 ft. diameter by 36 ft. deep, and was of three lifts, the inner 191 ft. 6 in., the middle 194 ft. 6 in. and outer 197 ft. 6 in. in diameter each by 35 ft. deep. The original structure was erected in 1890 to the ordinary design of the period, with lattice vertical stays in the inner lift as main members, and curved plates as secondary members, which had collapsed through corrosion and wear when the destruction took place. Bent plates formed the cups and dips; the inner and middle lift vertical stays being channel sections. Radial rollers only were provided. At the time of its collapse the holder was about 80 ft. high, i. e., the third lift was just out of water, when the crown lifted off bodily, allowing the inclosed gas to ascend into the air in a solid ball which caught fire, either from a neighboring stack or from a spark caused by the rending metal on the rapid descent of the structure. The heat was terrific, and everything in the vicinity was either scorched or burnt, but fortunately no great damage was done except to the gasholder. The clearing of the wreckage occupied considerable time, as it was necessary to take every precaution to ascertain the real cause of the collapse; and it was not until 1921 that a commencement of the reconstruction was possible. The new gasholder was redesigned, and it embraced many novel features.

Description of New Gasholder

It will be realized that as no sheets were being rolled in Australia at that time some delay occurred in obtaining material, but the sections employed were generally of Australian manufacture, being rolled at the Broken Hill Works at Port Waratah, Newcastle, New South Wales.

A completely new design for the holder was taken in hand by the drawing office staff of the company; and, as the different sections were completed, they were put in hand in the company's construction shops, thus enabling the fabrication of the structure to proceed without delay. A new timber framing of improved design was installed, as well as new tank guides. The general dimensions of the new holder are as follows:

Cups and dips were composed of 12 in. by 4 in. channel, and the 22 vertical stays of the outer and middle lifts were composed of three channels welded together; this welding was intermittent, i. e., not continuous throughout the length of the stays. The inner lift framing was paricularly strongly built, as the author considers it should be, and consisted of two channel iron sections braced together with double trian-

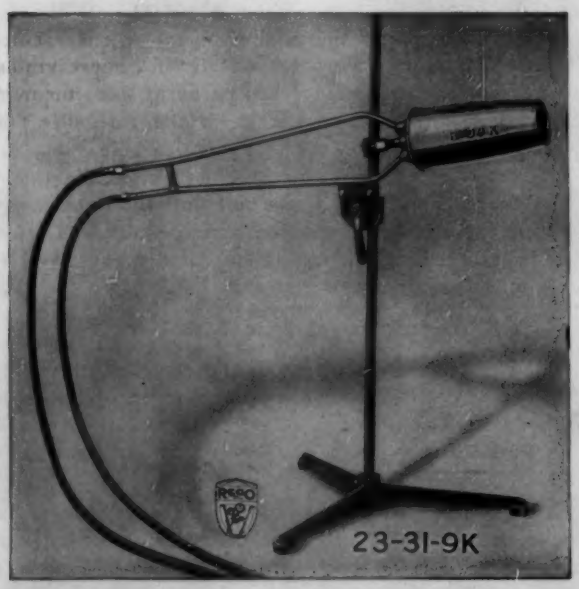
There is no subt

Stronger, Softer, Cheaper We

8-K hand pump generator burner is ideal for large welding shops, boiler works, railroad shops, ship yards and steel foundries where portability is important factor. Raw kerosene passed through torch and retort coil produces intensely hot flame 2½ feet long and 9 inches in diameter. Will heat castings, shafts and other large pieces of metal to a cherry red in a short time. Burns 1½ gallons of low grade kerosene per hour—pump tank holds 10 gallons. Six or eight strokes of the pump every half hour maintains the proper air pressure.

Price complete with pump, tank, burner, 10 ft. of hose and fittings. $60.00

9-K Air Blast burner is used extensively for heating shafts, gears, castings of any size prior to welding, straightening, expanding, lighting cupolas, drying ladles, skin drying moulds, baking cores, thawing ice out of switches, heating tires, etc. Produces a blue red flame 30 inches long and about 10 inches in diameter at its largest point, which when adjusted to neutral develops sufficient heat to melt cast iron. Consumes about 2½ gallons of oil per hour. Low grade kerosene, distillate, refuse oil, drainings from crank cases mixed with equal parts of kerosene, all give satisfactory results. Use 90 pounds air pressure such as is supplied by average garage compressor.



No preliminary heating required. The air pressure siphons the oil from the container. When the torch is needed the air is turned on and the jet of oil ignited.

Price, Burner, tripod, hose and fittings, complete..... $30.00
Burner without tripod 22.50

10-K Air Blast burner is a small outfit similar to the 9-K, used extensively for reclaiming damaged and bent auto parts such as axles, frames and shafts, brazing of bicycle and motor-cycle frames, and light preheating. Produces sufficient heat to melt cast iron. The blue red flame is 10 inches long and 2 inches in diameter at its largest point and will heat an auto frame a cherry red in five minutes. An ideal equipment for the garage, auto repair, and blacksmith shop. Uses 80 pound air pressure and consumes about 3 quarts of low grade kerosene per hour. Welded steel tank holds 1½ gallons of oil. The flame lights instantly without previous heating and stops burning as soon as the air valve is closed.

Price, Rego 10-K Burner complete..... $15.00

11-K hand pump generator burner uses low grade kerosene, and is similar in operation to the 8-K Burner. Outfit is extremely light and portable. The red blue flame 9 inches long and 2 inches in diameter produces sufficient heat to readily melt copper. Its small size and weight make it useful for heating the ignition ball on crude oil engines, straightening frames and axles, thawing road oil sprinklers, etc. Weight 8 pounds, burns 1½ pints of low grade kerosene per hour. Tank capacity 1 gallon of oil.

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gular bars. The curb angle was of 6 in. by 6 in. by ½ in. splayed to comform to the angle of the crown curb. The curb plate and hanging plate were each of ⅜ in. thickness. The vertical stays were affixed to the crown curb plate and hanging plate at the top, and to the cup at the bottom of the lift. A reinforcement angle was placed under the crown curb plate, and strong gusset plates, attached thereto, to the top of the vertical stays. The crown sheets, as well as all the side sheets, were of ⅜ in. thickness and electrically welded together by the quasi-arc process. This latter is believed to be entirely novel, and presented many interesting features and difficulties. In the first place, the sheets, which were of the largest size procurable, viz., 8 ft. by 4 ft., were originally welded in sets of four on the ground before erection; but this plan was early found to be inadvisable, owing to undue distortion, and the remainder were erected loose and fastened together with bolts smaller than the holes through which they passed; thus, ⅜ in. holes were used and ¼ in. bolts, to enable the sheets to move freely and to provide against the distortion due to contraction after the welding process. It is impossible here to describe in detail the many difficulties met with and the many disappointments, which at times were sufficient to dishearten the staff; and it was only by the most careful attention and experiment that all difficulties were at last overcome; and the sheeting as finished appeared as flat and perfect as any engineer could wish such a structure to be. Carriages were furnished at the top and bottom of each vertical stay, the adjustments of these being completed on the inflation of the holder with air in June, 1922.

Excellent Welding Results

There are 15 miles of welding in this structure, and there were not more than six leaks when tested. During the building of this holder continuous tests were being made with various joints, and these are still being carried out in order that the welders themselves and the designing staff may become familiar with the best types of joint and the best method of making them.

The building of this holder was proceeded with on the completion of the South Melbourne structure: and, as such pronounced success had rewarded our efforts in face of unparalleled difficulties, the author determined to carry out the problem of construction further by constructing this holder exclusively by electric welding. The holder originally erected here was contained in a brick tank 163 ft. in diameter by 25 ft. in depth and was of 500,000 cu. ft. capacity. Shortly after the author's arrival in Melbourne it was found to be in such a bad order, and so leaky, that it was put out of action. But the work of construction was delayed owing to more pressing gasholder work being essential. The design of the new holder provided for a structure of two and three-eighths million cubic feet capacity of four lifts, each 35 ft. in depth. The original tank was cut out of basalt subsoil; and the dumping was unfaced; the result being that disintegration had supervened and great boulders had fallen into the tank bottom. The base of the dumping was cut back to accommodate the four lifts and it was faced with 12 in. of concrete to prevent further disintegration. The tank wall was raised 10 ft. 6 in. by the erection of a reinforced concrete extension 9 in. thick at the top and 12 in. at the bottom, extending behind the top of the tank wall as an apron to take care of the additional pressure of the water exerted on the wall. That was especially necessary owing to the street surrounding the yard being some 7 ft. lower.

Novel Design of Extension Wall

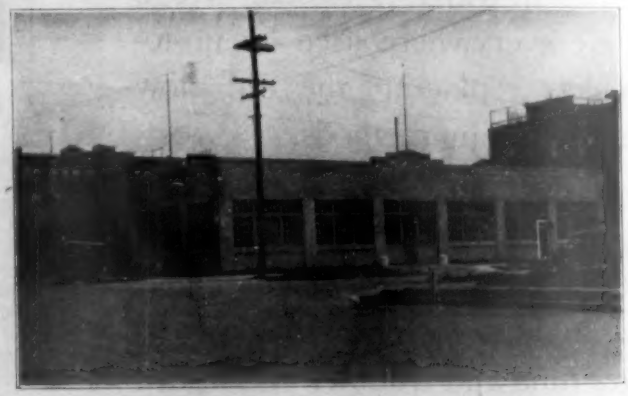
The design of this extension wall is novel and has proved in this and another similar case entirely satisfactory. The sixteen guide standards, with their horizontal members, were all latticed structures, entirely welded up. The standards were formed of two heavy steel channels 10 in. by 3½ in. and diagonally braced with angle irons. The horizontal struts were composed of four angle irons to which were welded angle iron diagonal bracing, thus forming box girders. These members, with the diagonal ties, were all welded up. The ties of the lowest bay were screw-adjusted before the second bay was welded up, and so on. At the top of the structure, which was of five bays, wind tie brackets extended radially inward and were connected with bar ties fitted with adjustable turnbuckles. All the various members of the guide framing were completely welded up in the workshop before assembling on the site, and to secure a minimum use of service bolts in the field. The four lifts and the crown were constructed in a manner similar to that of the new South Melbourne holder just described. Here, however, the experience gained on the former holder greatly facilitated the erection of this one. The total weight of the steel in this holder was about 760 tons; and in sixteen weeks twenty men, eight of whom were welders, completed the erection. The Fitzroy gasholder was subjected to rigorous examination and proved to be, if anything, a more effective piece of construction than the South Melbourne holder, and not a sign of a leak was anywhere discerned.

ACETYLENE WELDING USED EXTENSIVELY IN PACIFIC COAST MUNICIPAL SHOPS AND MOTOR BUS SHOPS

By C. W. Geiger

San Francisco, Oakland, and Los Angeles now have in successful operation municipal repair shops for the repair and maintenance of motor trucks operated by the various city departments.

The San Francisco Board of Public Works maintains repair shops and storage yards known as the "Corporation Yards," consisting of machine shop, blacksmith shop and paint shop



General View of Plant Where the Motor Busses are Repaired and Garaged in a Manner Similar to Railroad Trains.

which make all repairs on the motor trucks, automobiles and equipment of the Street Repairing Department, Street Cleaning Department and Sewer Repair Department.

The machine shop, blacksmith shop and paint shop are housed in a building of corrugated iron. The machine shop is equipped with portable acetylene welding and cutting equipment, which can be taken to any part of the yard for operation on any of the motor equipment.

A motor for operating the equipment in the machine shop is surrounded with a steel stand which not only protects the workmen but, being made of extra heavy material, also supports automobile engines when they are being repaired or worked on by the welding equipment.

At the repair shops of the San Francisco Fire Department an acetylene welding torch is used extensively in various kinds of welding, and especially in welding the gasoline tanks of the various fire equipment. These repair shops are housed in a $100,000 reinforced concrete structure and are equipped for repairing all types of fire fighting apparatus.

Acetylene welding is also used extensively in the Oakland municipal garage and repair shops. The municipal garage and repair shops include a complete machine shop, blacksmith shop, paint shop and two garages which provide storage for cars belonging to the following departments: Street, health, park, playground, harbor, engineering, auditors, electrical, building and public affairs. The garage and repair shops maintain and repair all these cars as well as the motorized fire apparatus, chief and battalion chiefs' cars, two patrol wagons

Portable Welding Equipment at California Transit Co. Shop in Oakland.

and all cars operated by the Police Department. A number of different pieces of apparatus have been and are being constructed in the municipal shop, these including fire apparatus, oil spreaders, trucks, etc.

The city of Los Angeles maintains four repair shops for repairing and maintaining motor equipment of the various city departments, all of which use acetylene welding equipment extensively. These shops are as follows: Engineering Department, Power and Water Works Shops, General Shops of the Water Department and Fire Department Repair Shops.

In the Fire Department shops there is a portable welding outfit which is used extensively in repairing electric light posts, fire and police alarm posts, etc., which frequently are damaged by motor trucks. If the repairing to be done to a post is very extensive, it is taken to the shop, otherwise the welding outfit is mounted on a truck and taken to the post. Repairs can be made for about one-third the cost of a new post.

The problem of repairing and garaging the 100 motor buses which are operated by the California Transit Company is taken care of by two plants, one at Oakland and the other located at Stockton, Calif.

The Oakland plant is housed in a reinforced concrete building located but a few blocks from the company's bus depot, which is strategically located in the business section of the city.

The motor busses are handled in a manner similar to railroad trains. As soon as a bus finishes a trip, it is run into the garage and taken to the Inspection Department, and inspected just as thoroughly as a railroad train.

When a bus is delivered to the Inspection Department the front end is raised clear of the floor, so that the inspector can make a thorough inspection of the front wheels, stearing gear and axle. After the front end is inspected the rear end is raised for the inspection of rear wheels, bearings, brakes, axle.

If after inspection it is found that it is necessary to do any welding, the acetylene welding equipment carried on a two wheeled hand truck is brought from the Welding Department and the work performed.

The California Transit Company not only make all repairs on the busses which they operate, but they also build all bodies and sell some.

ARC WELDING WORN FLASKS

By A. M. Candy*

One of the most recent applications of arc welding in foundry practice is that of repairing worn flasks. This operation is proving to be such a success and a marked economic saving that all foundry superintendents will doubtless desire to learn the details so as to take advantage of the process.

The illustration shows a pile of flasks which have been repaired with the exception of the one in the foreground. The upper malleable iron lug on this flask shows the hole in it to be worn to such a large diameter that the pin on the other half of the flask will not fit in it sufficiently tight to hold the parts in sufficiently good alignment. The practice in the past to make repairs has been to ream out the hole to a diameter of 7/8 inch and then press in a bushing having the right diameter hole, namely 5/8 inch. When the bushing wears too large it is then replaced with a new bushing.

The new method of repair, however, is even less expensive and much more satisfactory. The practice is to ream out the

Pile of Flasks That Have Been Repaired, The One In The Foreground Prior to Repair.

hole to 7/8-inch diameter and then fill the hole completely, using the metallic electrode arc welding process. A piece of copper is placed under the hole and the welding is done, using about 175 amperes and 5/32-inch diameter welding wire. The time required to weld one hole is about three minutes.

When these holes are again worn oversize it is not necessary to ream them out before the welding operation. The time required to weld a hole is then reduced to about two minutes.

The cost of welding each hole as originally drilled to 7/8-inch diameter is about as follows:

Labor at 70c per hour	$0.035
Welding wire at 8c per pound	0.016
Electric power at 3c a K. W. H.	0.013
	$0.064

The question naturally arises as to why it is necessary to drill a 7/8-inch diameter hole in the casting when only a 5/8-inch diameter hole is required for the pin on the flask. The reason for this is that there will be a layer of very hard chilled high-carbon cast steel about 1/8 inch thick in the region where the deposited metal unites with the casting, therefore, it is necessary to have the original hole 1/4 inch larger in diameter than the final hole so that no difficulty will be experienced in drilling the final hole through the deposited metal.

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Safety and Common Sense

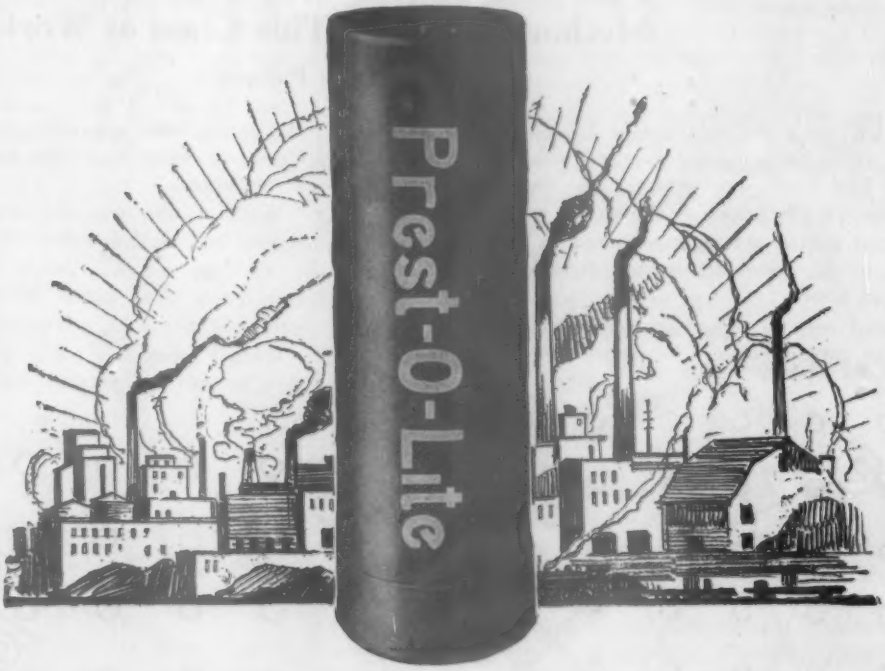
AT a recent meeting of the National Safety Council, one of the speakers stated that the most common type of personal injury in plants where welding operations were going on is burns resulting from contact with hot metal. It seems strange that men should have to learn by experience to associate hot metal with welding operations, but those who are interested in the industry will be pleased to note that the greatest part of the danger which exists is not due to any dangerous element in the apparatus. Personal injuries are also likely to occur through clumsy handling of heavy metal parts and careless organization of the work. There are not many safety rules which have to be observed in the handling of welding equipment. None of them are difficult to observe. Those who come in contact with it need to be cautioned to have the proper respect for the operating rules supplied by the manufacturers. The welder who uses any common sense need never have any accidents.

The Leak in the Pipe

WHEN a construction company in the far west made its first experiment with the laying of an oil carrying pipe line, the story is told that one welder left a small pin hole in one of his welds. A small amount of oil leaked out and was set on fire by a lighted cigar stub thrown on the roadside by a passing tourist. A prairie fire was the result. The welding operation was blamed for the entire loss and the exponents of welding had a discouraging time for a long while. The industry is having so many big successes in the line of pipe welding during the present year that it is interesting to review this incident of the early efforts. It may also serve as a lesson to the engineers who are trying to perfect new applications and to make welding possible where it has been considered impossible before. The pessimist will seize upon the slightest imperfection as an excuse to condemn the process as a whole. Get good welders and have the work done right.

Helping Welding Schools Make Good

ACTIVE cooperation will be supplied to welding schools in all parts of the country through the recently organized educational committee of the Gas Products Association. The first investigation made will naturally aim to determine what is needed in the way of instruction, which means that critics of welding school graduates will be urged to make their wants known. Practically all of the schools are honestly desirous to make their instruction as valuable as possible to the student and his employer. They have so far responded gratefully to suggestions for improvement, expressing a willingness to make their instruction conform to the requirements of the welding shop. If the work of the committee can be carried on as planned it will be one of the most constructive activities of the year in the oxy-acetylene welding industry. A well equipped school is the ideal place for a man to learn the fundamentals of the welding trade, because in such a place the entire time, and attention of the personnel is given over to instruction. There has always been an impression that this instruction is superficial and inadequate, but it need not be so. If given proper information as to what is wanted the instructor who has the student welder under his supervision for several hours a day can do a lot for him. It is up to the employer to take a more active interest in the instruction given, and then be prepared to start in with the student where the instructor left off and give him the special instruction needed in that particular shop. There is no better way to advance the welding industry than to help these schools in their effort to teach welding. It must be remembered that the welding school will continue to be the only institution properly organized to furnish new welders until the trade becomes so well established that a satisfactory apprenticeship system can be developed. The school system of teaching has no faults which cannot be corrected if criticism is made in a constructive way. The trade will become more popular and atfract a better class of workmen when the means for learning it are better organized.



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DISSOLVED ACETYLENE

WELDING CRACKS IN SIDE SHEETS

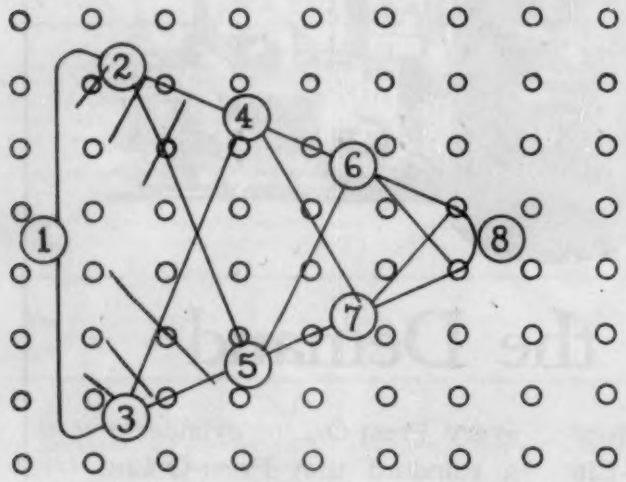
Four Old Timers Give Their Favorite Methods of Doing This Class of Work

By R. P. Palmer

WHILE on a Pullman bound for the south one night, I entered the smoking room for my last smoke before retiring. The room was occupied by four gentlemen who were discussing the topics of the day.

I had just gotten my cigar adjusted to the right position, when one of the occupants started describing a welding job that he had done.

I adjusted my receiving set and settled down to enjoy myself, but after listening for some time I decided to do



Sketch A.

some broadcasting. I started by referring to an article which I had seen in *The Welding Engineer*—"Welding a Pipe Line Under Pressure," and much to my surprise three of the four immediately said they had read that same article. So I said, "I believe it's time we got acquainted," as there were four of us in that room who were interested in the welding trade.

It was not long before the conversation drifted to the subject of welding cracks in side sheets. I believe this is about as difficult a line of work as you will find in welding.

The first man explained his method as follows: "The difficult part of welding a crack in a side sheet of a fire box is not the placing of the metal in the V, nor is it the proper fusing, but it is expansion and contraction.

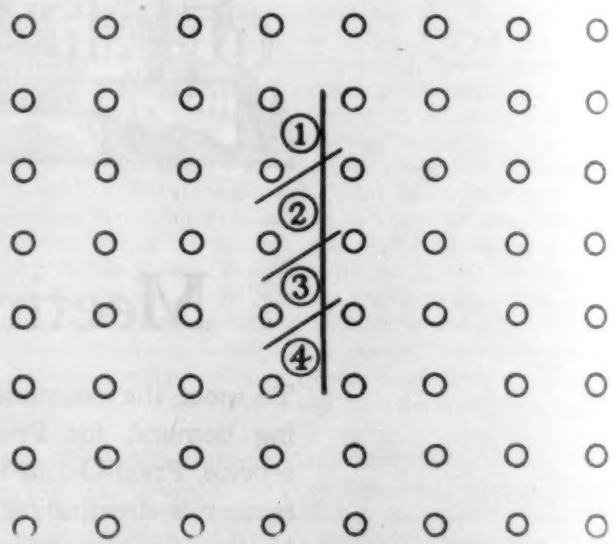
"When I am called upon to weld a job of this kind I first V out the crack with a cutting torch, then I measure the length of the crack and start at the bottom and make a cut the same length as the crack in an upward direction at a forty-five degree angle with the crack. I next V this out, then I start at the top of the crack and make a similar cut the same length in a downward direction at a forty-five degree angle and at the three corners I make a round corner instead of a square one. I use the electric process for welding, using five-thirty seconds size wire.

"I commence welding the original crack marked 1 in sketch A. After completing this weld, I mark the remaining part in six-inch lengths. Now, if you have been using your grey matter you will see that the part marked 1, which I have just finished, is one hundred per cent strong. We next weld two, then down to three and so on until complete. Now if you will notice where the pull is going to be, you can see number 2 will draw up, but number 4 will draw at an angle. Let's draw a line to number 3, you can now see the contraction is equalized so that no part has any great strain. I have used this method a number of times with great success."

Well, as this was the end of the first welder's story, a second one started, but a third interrupted him by saying:

"Did you see that article in *The Welding Engineer*, where that fellow Shep wrote about a welder he saw who could weld and not have any sparks flying from the weld?"

Well, I'll say this much, if Shep has tender feelings I am glad he was not present, but anyone is liable to make mis-



Sketch B.

takes, so we decided since it could not be true it was a case of too much enthusiasm.

Well at last number two got the floor and proceeded to explain his way, which is as follows:

"I first V out the crack with the cutting torch then finish the V with a chipping chisel so that I get clean metal to weld on. I start at the top and mark the crack in four-inch lengths and start at the bottom of number 1, (sketch B) and weld up. After completing number 1, I start at the bottom of number 2 and weld up to number 1, and so on until complete. Of course I do not say this will hold every time, but I have fairly good success and use either the electric or the acetylene process."

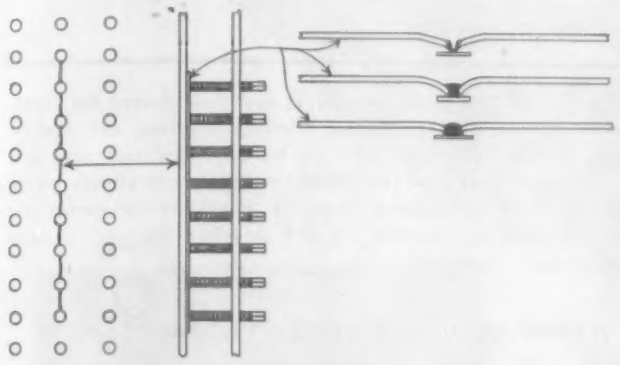
As soon as number two had finished his story, the fifth occupant of the room, who was an old man, began by saying:

"I am very glad to know that you boys are not of a selfish nature. I mean by that, that you are willing to tell other people your experiences that they may profit by them. If you were to know all about welding and were to keep it to yourself, when you die no one has gained by your experience."

Number three said he wanted to tell us about one job he did:

"The crack was in a side sheet and was thirty-two inches in length. It was vertical and extended through eight staybolt holes. We removed the staybolts and V'ed the crack with a cutting torch and finished the V with a chipping

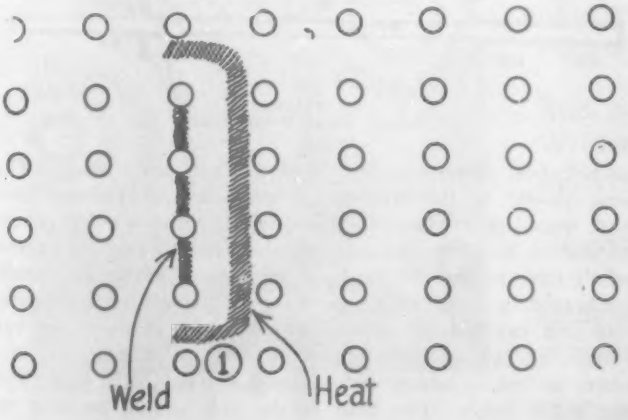
chisel. I used the welding torch to heat the metal adjoining the crack, and used a fuller to drive the edge in about three-eighths of an inch. (See sketch C.) This was to take care of contraction. I next tacked two welding rods on a piece of boiler plate, one-quarter inch by one and one-half inches by thirty-two and one-half inches. I bent the rods and inserted the plate in the crack, then pulled on the rods until they straightened and allowed the plate to fit against the side sheet, completely covering the crack. I next got eight staybolts made so that they



Sketch C.

would be a tight fit in the holes of the side sheet, began welding at the bottom of the crack, using oxy acetylene and as soon as the weld was complete I went outside and began to screw the staybolts in. The end of the staybolts came directly against the plate which I put over the crack. I continued to force the bolts in, giving each one the same amount of turns, and they forced the welded part out flush with the side sheet, and that job has been holding for eight months without further trouble."

Well my turn was next so I started like this:



Sketch D.

"Small cracks in sidesheets are quite common. They usually start between two staybolt holes, about four inches in length. The welder is called to the job and he says, 'that is just a small job,' and he proceeds to weld without giving expansion and contraction a thought.

"The result is that the engine makes about two rips and then there is a crack about one foot in length, including the old weld. The best way to overcome this is to first V the crack and be sure it is quite clean to work on. Next be sure every drop of metal is properly fused, and after starting to weld a crack be sure there is no interruption. After the weld is complete, using either electric or acetylene, start and one-half inches wide the entire length of the weld, keep- to heat at number 1, (sketch 1) and heat a place about one ing at least three inches away from the weld at all times. Keep passing the torch over the entire length of the heat. Take a damp piece of waste and rub on your weld to induce contraction, making the waste damper until the weld is almost cold.

"Now you can see what has happened. The contracting weld has stretched the adjoining metal. You say the weld will be hard because we cooled it too quick. No, it will not. The heated surrounding metal will cause the weld to get hot enough to anneal it and no trouble will be experienced and I will positively guarantee this method."

Upon looking at my watch I found it was past bed time, so we all retired, hoping to meet again.

SMITH ANNOUNCES NEW CAST IRON REPAIR PROCESS

A four-page circular just issued by Smith's Inventions, Inc., Minneapolis, Minn., features the use of a new product called Smith's A-MAL-GAM. This is a newly perfected material and claims that anyone wanting to use a torch can in a few minutes weld cast iron with bronze without preheating. It is recommended for use in the following jobs: Pin or blow holes, cracks or breaks in cylinder heads, water jackets, etc., scorched cylinders, automobile parts, air compressors, rotary pumps, pump castings, water tight castings, plumbing tight fittings, cracks and vacuum systems, hot water filling boilers, hot water boilers and steam radiators, cast iron and steel and copper water tanks, commutator ends, motor frames, cast iron chemical apparatus, general engine room repairs, water mains and fittings, brass to cast iron welding, copper to cast iron welding, steel to cast iron welding.

The following directions for the use of this new compound indicate the ease with which some cast iron repairs can be made. Chip or grind out the crack to form about a 90 degree groove. Use a welding tip to bring a spot on cast iron to a dull red head in about one minute. Heat the bronze rod and tip into A-MAL-GAM. Rub the A-MAL-GAM into the break and as soon as the iron reaches a dull red heat start welding. In welding breaks over 2 or 3 in. long, it is best to weld only about 2 in. at a time. See that the A-MAL-GAM runs ahead of the bronze.

The A-MAL-GAM is packed in a moisture proof non-tipping can, so designed that the user can reach all the corners and get the use of all of the contents.

ASSOCIATION OF IRON AND STEEL ENGINEERS TO MEET

John F. Kelly, National Secretary of the Association of Iron and Steel Electrical Engineers extends to the readers of the *Welding Engineer*, a special invitation to attend the iron and steel exposition, being held at the Broadway auditorium, Buffalo, New York, September 24th to 28th, 1923.

Over one million dollars worth of apparatus will be on display and will represent what one hundred and fifty of the largest manufacturers in the United States have developed for the use of the industries during the past year.

A special feature will be the complete electrified foundry which will be in actual operation producing finished castings. Starting with the electric furnace, every operation known in modern foundry practice will be exemplified and as this is the first time that this feat has been attempted in America, it will attract thousands of foundrymen from all over the United States.

The technical sessions which are held in connection with the iron and steel exposition have all been prepared with a view of imparting the practical experiences and data obtained by the engineers in the field of operation.

Hints for the Welder

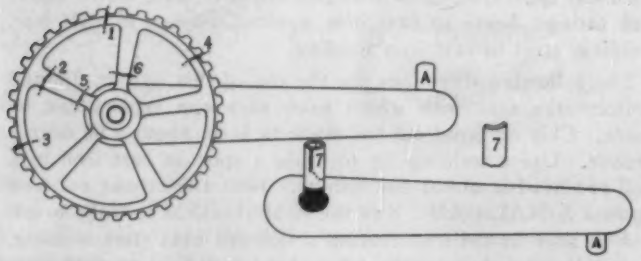
When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

WELDING SAVES TWO-THIRDS THE COST OF REPLACING BROKEN WHEEL

By E. A. Olden

One of the most interesting jobs handled in our shop was a cog wheel and arm of a portable gas engine saw rig. The cog wheel was about 10 inches across and the saw is attached to the arm at A. It was brought to our shop last spring by a farmer, who insisted that we weld it, and you couldn't blame him, for a new one would cost around $18.00. (It was broken by a tree falling on it.) We advised him to get a new one, because we hated to tackle the job and because it might not turn out to be satisfactory. However, after it had lain around two or three months and I ran out of something to do, I gathered up the pieces and prepared the broken edges with a file, and proceeded to stick them together.

I have numbered the broken pieces, as I welded them



Reclaiming Cog Wheel and Arm of a Portable Gas Engine Saw Rig by Welding.

in numerical order. After I had welded No. 1 and No. 2, I took this part of the wheel and set it against 3, 5, 6 and 4. Somehow it had expanded about the width of a match wider across from 3 to 4. So I filed it down a little at 3 and 4, and I divided the distance, making it extend slightly over at 3 and 4, instead of letting it extend over at either 3 or 4. Of course I took care to make the broken parts line up.

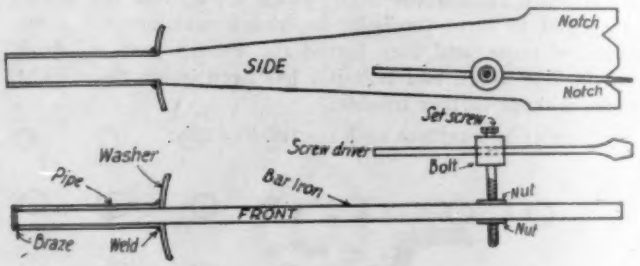
Next I took the lower part of the wheel and braced it well in a fire place with the broken parts up. Then I set the part I had welded on top of it, bracing it in position.

After preheating I stuck it well at 3 and 4. Then I turned the wheel on its side in the fire and welded 5 and 6 on one side. Then I finished 3 and 4, then turned it over and finished 5 and 6. I covered it up with ashes in the fire and left it to cool. It came out all right and it would take a good eye to tell whether the part of the wheel I put on at 3 and 4 was any wider than the other part. Next I welded No. 7 on the arm. It was broken right along the edge of the key seat and then across. This part I welded on the inside first. This causes it to draw firmly together, making it fit in the hub of the wheel. It also causes the drive shaft of the engine to fit in the arm. It is essential that this part be welded on the inside first, or else it must be firmly clamped together, otherwise it will tip up and won't fit and will have to be filed down. It is hard to do a square fitting job along the key seat, but if the oxygen is kept low during the welding it can be filed to shape. Perhaps another and just as good way would have been to have welded this arm and piece No. 7 right into the wheel, making them all one piece. This may not be as good as a new wheel but the owner got the job done for around a third of what the cost of new parts would have been.

HANDY TOOL FOR SHEET METAL WELDERS

Editor:

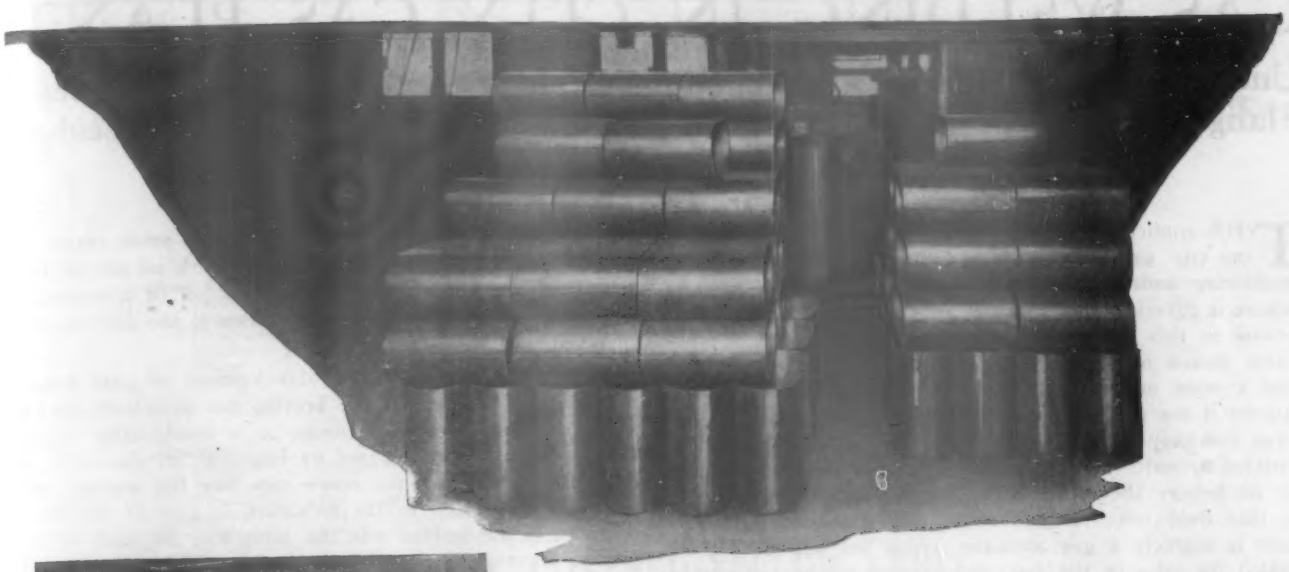
I am sending you a sketch of a tool, that will practically give the sheet metal welder an extra hand while tacking metal up to 14 gauge. It can be made any size desired, but I find that about 16" by 2¼" over all, with the handle no longer than the palm of your hand is wide, (about 3½") is the best, because at certain times you can use your shoulder



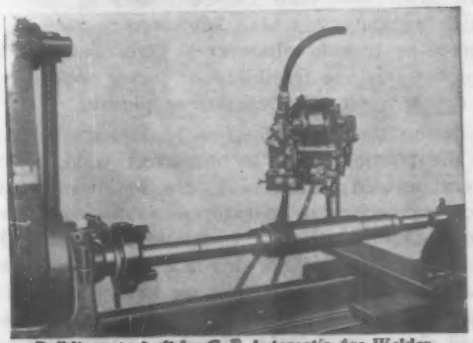
Handy Sheet Metal Tool.

to help bear down and your hand will act as a cushion. The pipe should be flattened out a little to give an oval grip and should be welded to the washer. The washer should be dished, and large enough for the hand to rest on so you won't have to grip so hard on the tool. The handle should be brazed in place so if you want to change for a different size you can heat it up and knock it off easily. The bar should be ¼" or slightly thicker, because metal can quite often be put in place with a twist instead of a push, and the width helps. The head of the bolt should be built up to the desired size. The bolt should be about ⅜" and have a lock nut on each side of the bar and a set screw in the head. This will let you move the driver to the position you find most convenient. The notch that is in line with the screw driver should be on the bottom when the screwdriver is on the left, (for right handed welders.) The free notch, on top, is to be used when the sheets are in line and there is no use for the driver. To use, tack both corners first. Then tack the places that are the most out of line. Use the screwdriver to hold the part out that tries to buckle in and the notch to bear in with. As the tacks get closer, change to the notch on top and just use the screwdriver as you would a separate pry when necessary. The screwdriver should be made of good material and ground as thin as possible. If it bends or cracks, regrind and lower it.

R. J. Liechte



Straight seam welding of tanks by G-E Automatic Arc Welder.



Building up shaft by G-E Automatic Arc Welder.

Automatic Arc Welding

The above picture shows 50 tanks welded by a G-E Automatic Arc Welder in a half day, as compared to 21 tanks welded by the hand method in a full day. The metal welded is 1/8″ thick by 24″ long.

Through this automatic application of the electric arc, a steadiness of the electrical conditions in the arc is obtained and maintained, resulting in a uniform and high quality of weld—and higher speed. Higher welding speeds produce lower welding costs.

The principal field for the G-E Automatic Arc Welder is the production, by welding, of duplicate objects in considerable quantities.

Its greatest use is for straight line seam, which is the simplest form of weld—but it also does efficient welding of circular seams, and in building up processes on metal.

G-E welding engineers will cooperate with you in making suitable applications of the Automatic Arc Welder to processes of production in your plant. Ask them.

General Electric Company
Schenectady, N. Y.
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GENERAL ELECTRIC

4SB-719

GAS WELDING IN CITY GAS PLANT*

Underground Steel Main Construction—Welded Steel Pipe and Extra-Heavy Flanged Steel Valves with Welded Companion Valves Put End to Leakage

By E. E. Lungren†

THE application of the process of acetylene welding in the city gas industry is a distinctly unique one when considering underground steel main construction, especially because it covers a field which is very large in its scope, and because in this branch it probably stands alone as a practicable means of welding pipe. It is amazing to consider what a wide outlet the gas industry provides for welding material if the proper missionary work is done, for we find a gas company in practically every city in the land. The continual growth of the gas industry is an assured fact, and we believe the future will bring an unbounded demand for this fluid heat for industrial and domestic purposes. There is scarcely a gas company which has not more than doubled its sales in the last decade, and present economic conditions point to an even greater increase in the next. This necessitates the rebuilding of distribution systems, the extension of existing mains and in a great many cases it requires higher pressure on gas lines. The question then arises with the distribution engineer of how he can best keep pace with modern practice in pipe-line construction.

The adoption of the practice of welding steel pipe has proceeded to such a stage that it is no longer experimental, and there are certain very definite reasons why it has the advantage over other methods. The mere fact that most of the larger companies have taken up the process and use it very extensively is proof that they are finding it of distinct advantage. The natural gas companies which deliver great quantities of gas under high pressure were pioneers in pipe welding on a large scale, and they have adopted it quite generally especially in the southwestern field.

The company with which I am associated has welded all its lines for the past seven years, and from this experience we are in a position to state why we have found welding more advantageous than the use of screw pipe. Perhaps the most outstanding advantages of welded joints are the reduction in leakage, the increased strength of the lines, and the lower cost together with more rapid progress in construction work.

The most important of these is the matter of leakage. Our company has about 370 miles of high-pressure trunk lines carrying artificial gas at initial pressure of from seventy to ninety-five pounds, and some 900 miles of mains operating under medium and low pressures. The majority of these lines were laid with screw pipe and as may be expected, the screw joints are a continual source of leakage trouble, necessitating the expensive practice of covering the couplings with rubber-gasketed leak clamps. This expense, however, is a small matter compared with the value of the gas lost through leakage, which is a staggering figure. Lines laid with screw pipe may be made gas-tight when installed, but we know that a great many joints will develop leaks while in service, and it is in this point that the welded joint shows its chief advantage. The welded joint, when properly made, is as impervious to leaks as the pipe itself, and when found to be perfect on its original test we have positive assurance that no leaks will develop in service. This statement is substantiated by our experience with 172 miles of welded pipe lines, ranging in size from 1½" to 12" pipe, the greater part of which are carrying gas at high pressures, and which have been in service from one to seven years. We have had practically no maintenance work on any of these lines and we know from the examination of a number of joints that they are in as good condition as the day they were installed.

Next in importance to the development of joint leaks is the constant danger of line breaks, due principally to contraction stresses and sometimes to a combination of contraction with stresses caused by improper installation of the line. In the case of the screw pipe line the weakest point is in the joint, due to the reduction in area at the thread, whereas in the welded line the joint may be made of even greater cross-section area than the pipe, which makes possible a line of uniform strength throughout. Regarding contraction stresses it is very rare to find gas lines subjected to temperature variation of more than 100°F, and through this range the stress set up is scarcely more than one-third of the ultimate strength of the steel. Hence we have not found, and do not expect to find a line-break except at a weak point where there is a fault. Then, too, all cast-iron fittings, which are a source of weakness, can be eliminated since the welder can make any kind of fitting that is desired in the field. By the use of extra-heavy flanged steel valves with welded companion flanges, which have as great strength as the pipe itself, we obviate the necessity of expansion joints, and our line becomes practically one solid piece of steel. Such strength can be approached in no other way.

As an example of the resistance against contraction stresses we have a 4" welded line twenty-two miles in length laid in very rugged country where there is scarcely any level ground or straight right-of-way, and which was laid in a plowed furrow with less than twelve inches of covering. This line, which we know has been subjected to very severe strains, has given no trouble whatever in three years service. This also demonstrates the feasibility of laying welded lines at a shallow depth when other conditions permit.

When considering the strength of welded joints we must not overlook the possibility of an imperfect weld, for we have had several welded joints break, due to improper care on the part of inexperienced operators. Four clean breaks in welded joints out of about fifty thousand joints made has been our experience, but we think this is a good record when consideration is given to the fact that we have trained most of our operators, and during the development stage in any craft misfits will always be found. Mention of this impresses on us that great care should be exercised in choosing operators. We have never had a faulty weld by any of our experienced men.

When we decided to adopt the welding process in laying mains the matter of cost was scarcely considered, for the company was determined to put an end to the leakage problem as far as new lines were concerned, with almost no regard for cost. Some fear had been expressed that the high cost of welding would make it prohibitive. On the contrary we found after our first year of welding, during which we installed about fifty miles of pipe lines, that the cost was actually somewhat lower than it had been for screw joint lines which were installed by well organized crews with years of experience. This is a fact which we have determined to our own satisfaction, and still we think that the matter of comparative cost is of too little importance as a balancing argument to be compared with the other advantages of welding.

Paper read before the International Acetylene Association, Chicago, October 26, 1922.

†*Western United Gas and Electric Company*

ELECTRIC "RACO" OXY-ACETYLENE

MILD STEEL and IRON WELDING WIRES

"RACO" BLUE LABEL

Analysis:

Carbon	not more than 0.18%
Manganese	not more than 0.60%
Phosphorus	not more than 0.025%
Sulphur	not more than 0.04%
Silicon	not more than Trace

This wire is admirably suited for all general repair and production work. For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings. It is unusually smooth in finish and free from any trace of grease or rust.

The steel from which "Raco" Electric Welding Wire is manufactured is made by the basic open hearth process and the wire is drawn with great care to insure evenness in structure.

"RACO" WHITE LABEL

Analysis:

Carbon	not more than 0.06%
Manganese	not more than 0.30%
Phosphorus	not more than 0.02%
Sulphur	not more than 0.04%
Silicon	not more than Trace

This wire may be used with success wherever imported Norwegian or Swedish wire has been considered necessary.

"RACO" COVERED YELLOW LABEL

Analysis:

Carbon	not more than 0.18%
Manganese	not more than 0.60%
Phosphorus	not more than 0.025%
Sulphur	not more than 0.04%
Silicon	not more than Trace

"RACO" Covered Electrodes are used with either alternating or direct current where bare wires will not give satisfactory results.

"RACO" HIGH CARBON

Analysis:

Carbon	0.85-1.10%
Manganese	0.30-0.60%
Phosphorus	not more than 0.04%
Sulphur	not more than 0.04%
Silicon	not more than 0.04%

for welding with direct current high carbon steel and worn surfaces where great resistance to abrasive wear is desired such as rails, frogs, switch points, bearing surfaces, etc.

"RACO" HIGH CARBON COVERED

Analysis:

Carbon	0.85-1.10%
Manganese	0.30-0.60%
Phosphorus	not more than 0.04%
Sulphur	not more than 0.04%
Silicon	not more than 0.04%

for welding with alternating current high carbon steel and worn surfaces where great resistance to abrasive wear is desired, such as rails, frogs, switch points, bearing surfaces, etc. This wire is manufactured especially to conform to specifications E-No. 1C of the AMERICAN WELDING SOCIETY.

"RACO" RED LABEL

Analysis:

Carbon	not more than 0.06%
Manganese	not more than 0.30%
Phosphorus	not more than 0.02%
Sulphur	not more than 0.04%
Silicon	not more than Trace

"RACO" MILD STEEL RODS FOR OXY-ACETYLENE WELDING

Copper Coated

Answers the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies such as the American Bureau of Shipping, the Interstate Commerce Commission, etc.

Colored labels in this style identify each different kind of RACO WIRE.

The Reid-Avery Company produces "Raco" Welding Wires *only*. It has no other welding interests. This fact in itself is a guarantee of quality and satisfactory service.

The analyses presented here, and which may be thoroughly depended upon, make it possible to standardize on one or two wires for all, or practically all, uses.

Each package bears a tag plainly indicating customer's requisition and order numbers as well as grade and size of wire.

Inspection may be made either at our plant or at destination as may be most convenient.

"Raco" Wires are uniformly well finished—bare wires are smooth and absolutely free from grease or rust. Coverings, where used, are carefully baked on to insure permanency.

Samples for testing and descriptive booklet sent promptly

REID-AVERY COMPANY

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21st STREET AND WASHINGTON AVENUE

PHILADELPHIA, PA.

I have remarked that in welding pipe lines more rapid and smoother progress can be made. The twenty-two mile line of 4-inch pipe which I mentioned was completed in less than two months, using six welding crews, which is much faster than we ever laid a similar amount of screw pipe. The ease of organizing welding crews has very much to do with the rate of progress in line work, there being more individual work and less of the team work of brawny men as required in screw pipe line construction.

The welder is master of the steel and this means a great deal in pipe-line work which is often done in isolated places, far from the machine shop or jobbing house. He needs only his welding material and the pipe to complete a line through the most inaccessible places, since he is able to cut and weld to shape the pipe into any kind of a special fitting that may be required. There are no rush trips back to the shop for special wrenches, dies, or fitting, etc., on account of unforeseen conditions which always seem to occur on a rush job.

In pipe-line construction there need be no particular cooperation between the welding crews and the trench excavation in a great many instances. In fact a great deal of the welding may be done prior to trenching, as it is very often possible in rural districts to make up long sections which can later be tied in before dropping into the trench, a practice which is quite impossible with screw pipe without the use of the rubber-gasketed sleeve. The line may be built entirely above the trench, tested for leaks and rolled into the trench. Ordinarily no particular care in handling need be exercised with the completed line of the smaller sizes, for a little rough usage at this time may prove to be a good test of the joints. One of our earliest jobs was a five-mile run of 8-inch pipe which had no valves or fittings throughout its length. The line was made up in sections with the pipe set up on blocks, which allowed turning so the operator could always weld on the top of the pipe, a method which we call the turning weld. When the section became unwieldy it was tied in to the end of the main which had been completed and which had been retained above the trench. On this line about 85 per cent of the joints were "turning" welds and only three joints were made in the ditch, one at each end of the line and one at a river crossing below the river bed.

Aside from its use in pipe-line construction, the use of the oxy-acetylene torch in the gas industry is not different from what we find in the arts generally. In the gas manufacturing station it is one of our most essential tools and we are constantly learning how to make it do more of our construction and maintenance work in a time-saving and efficient manner. We have made rapid repairs to boilers, tanks, shafting, steelwork and castings generally in cases too numerous to mention. One job which consisted of repairing a gas holder at one of the smaller stations proved welding to be a very good way out of a very bad bargain.

The holder, which has 30,000 cu. ft. capacity and is forty-four feet in diameter, was in need of an entire new crown. To rebuild the crown with riveted plates was out of the question since the gas service could not be discontinued for the period required. The possibility of welding an entire new crown was then resorted to. Before shutting down the holder the steel plates were all prepared to match. After landing the holder, the plates were hoisted into position, welded together and the whole welded to the outer edge of the existing crown just inside the circumferential rivets. The job was done in about eighteen hours, and it proved to be entirely successful.

Referring again to the adoption of oxy-acetylene welding by the gas industry it may not be amiss to make recommendations based on our experience in seven years practice.

1. All steel gas mains should be laid with welded joints.
2. Great care must be taken in employing operators of sufficient experience, and operators' working conditions should be made as comfortable as possible.
3. Standard makes of welding apparatus should be used, as it is poor economy to experiment with the cheaper and untried grades. Apparatus manufacturers should be very explicit in their directions regarding proper care and handling of regulators, gauges and hose in order to insure safety, and to guard against leakage of gases.
4. We have found the 45° bevel on pipe ends to be best suited for welding, and we specify this in all purchases.
5. We believe the slightly greater cost of Norway iron warrants its use to the exclusion of cheaper grades. We use the $\frac{1}{8}$-inch wire in practically all work.

I wish to acknowledge the assistance of Mr. C. C. Boardman, of the Western United Gas and Electric Company, in the preparation of this paper.

F. A. WILSON-LAWRENSON T OSTUDY ECONOMIC CONDITIONS ABROAD

Too Close Application to Business Causes Resignation from Union Carbide & Carbon Co.

For the purpose of making an intensive study of economic and business conditions in Europe and Asia, covering a period of several months, Mr. F. A. Wilson-Lawrenson has resigned his executive positions with the Union Carbide and Carbon Corporation and its various subsidiaries, with which he has been connected since 1917. Too close application to his heavy duties as Vice President in charge of sales of the Prest-O-Lite Company, Inc.; of the National Carbon Company; of the American Eveready Works, as well as in other capacities, have made it necessary for Mr. Lawrenson to conserve his health, which his devotion and strenuous work on behalf of public and civic enterprises has somewhat impaired. The change of interests involved in the extensive travel abroad that he has planned will give him, it is thought by his medical advisers, the much-needed relief.

Since the war period, during which Mr. F. A. Wilson-Lawrenson served the government as assistant Food Administrator for New York, he has been markedly prominent in public and business life. As President of the Advertising Club of New York his progressive and constructive labors did much to bring that organization into international prominence, and he was appointed by the President of the Associated Advertising Clubs of the World as a special delegate to visit London and consult with the Prime Minister, Mr. Bonar Law and the leading business men and publishing interests in England as to the advisability of holding the International Advertising Convention in London in 1924. After several months travel through England and the European countries, he arranged for the visit of a huge British delegation of advertising men and newspaper men who succeeded in securing at the Atlantic City Convention the pledge of American advertising men to visit London in 1924. For his services in this regard Mr. Lawrenson was honored with membership in the Thirty Club of London.

As chairman of the Committee on the Economics of Advertising Mr. Lawrenson made many constructive contributions to this phase of the commercial life of the United States. The Civitan Club of New York was organized by Mr. Lawrenson and under his presidency the Club has taken an active and progressive part in civic betterment. As a member of the Publicity Committee on the celebration of New York's Silver Jubilee he was able to do much brilliant work which contributed in a great degree to the success of that municipal enterprise.

There are few men whose work among the electrical and hardware interests of the United States are better known. It was with great regret that the Union Carbide and Carbon Corporation accepted Mr. Lawrenson's resignation, but it is felt that the work he will be able to do in the next few months in Europe and Asia will be of great help to American business.

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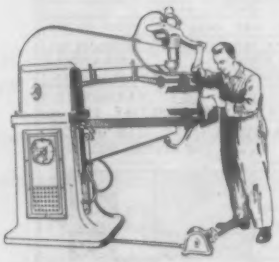

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Electric Welding in Railway Shops

Its Application and Use in Locomotive Construction and Repair —Earlier History of Welding—Practice in Locomotive Shops

By W. E. Symons

THE actual saving in dollars and cents plus other resulting economies such as the reduction in time for renewals and repairs, restoring worn or broken parts, etc., through the application of thermit welding, electric and gas welding and cutting in railway, industrial and marine fields, will run into the stupendous figures of hundreds of millions of dollars.

The purpose of this article is to show the importance and tion from a paper by Mr. Harry Ruck-Keene read at the Engineering and Machinery Exhibition in London, September, 1907.

"The ordinary form of welding can certainly not be called a new process, for though I have been unable to find who is the first discoverer of the art of welding, yet on referring to the

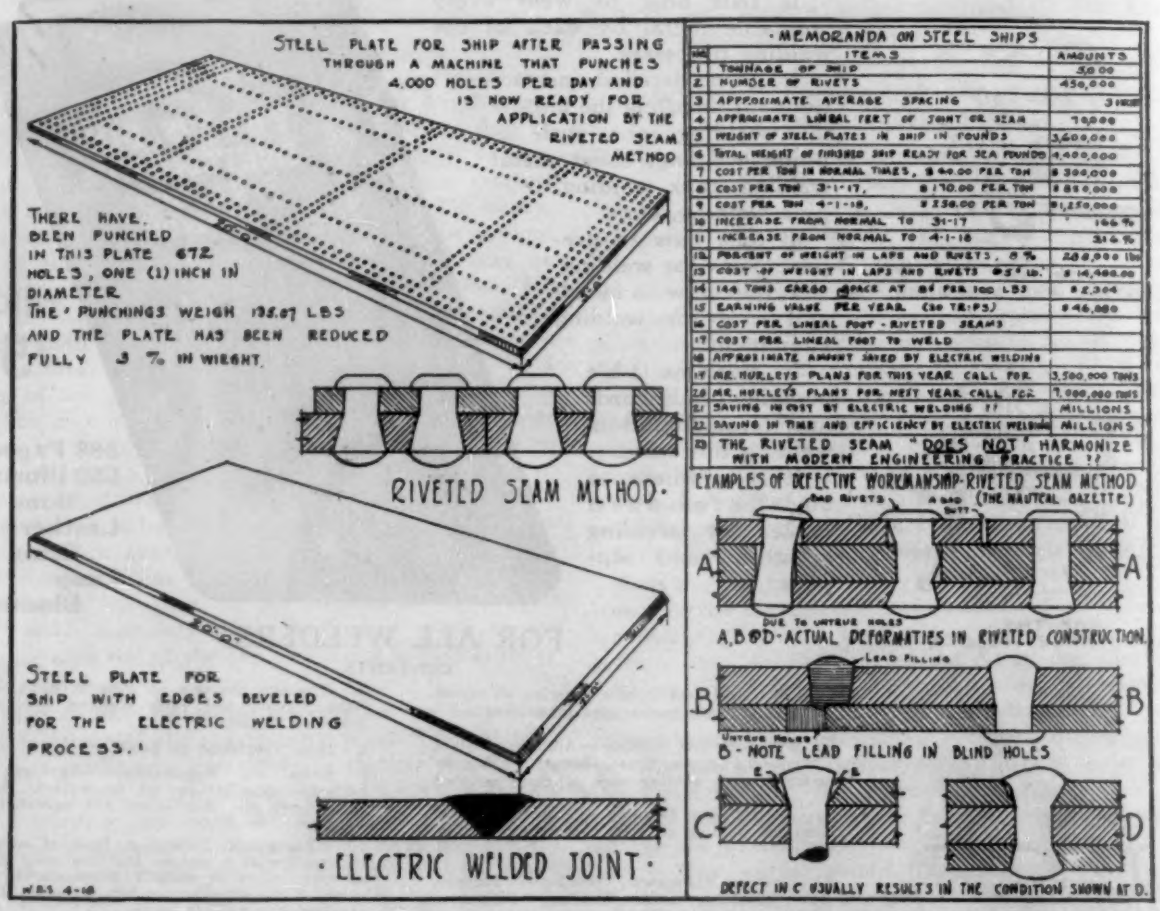
STEEL PLATE FOR SHIP AFTER PASSING THROUGH A MACHINE THAT PUNCHES 4,000 HOLES PER DAY AND IS NOW READY FOR APPLICATION BY THE RIVETED SEAM METHOD
THERE HAVE BEEN PUNCHED IN THIS PLATE 672 HOLES, ONE (1) INCH IN DIAMETER
THE PUNCHINGS WEIGH 135.07 LBS AND THE PLATE HAS BEEN REDUCED FULLY 3 % IN WIEGHT
RIVETED SEAM METHOD.
STEEL PLATE FOR SHIP WITH EDGES BEVELED FOR THE ELECTRIC WELDING PROCESS.
ELECTRIC WELDED JOINT.
MEMORANDA ON STEEL SHIPS
ITEMS
AMOUNTS
1 TONNAGE OF SHIP 5,000
2 NUMBER OF RIVETS 450,000
3 APPROXIMATE AVERAGE SPACING 3 INCHES
4 APPROXIMATE LINEAL FEET OF JOINT OR SEAM 70,000
5 WEIGHT OF STEEL PLATES IN SHIP IN POUNDS 3,600,000
6 TOTAL WEIGHT OF FINISHED SHIP READY FOR SEA POUNDS 4,400,000
7 COST PER TON IN NORMAL TIMES, $ 60.00 PER TON $ 300,000
8 COST PER TON 3-1-17, $ 170.00 PER TON $ 850,000
9 COST PER TON 4-1-18, $ 250.00 PER TON $ 1,250,000
10 INCREASE FROM NORMAL TO 3-1-17 166 %
11 INCREASE FROM NORMAL TO 4-1-18 314 %
12 PERCENT OF WEIGHT IN LAPS AND RIVETS, 8 % 288,000 lbs
13 COST OF WEIGHT IN LAPS AND RIVETS @ 5¢ LB. $ 14,400.00
14 144 TONS CARGO SPACE AT $5 PER TON LBS $ 2,304
15 EARNING VALUE PER YEAR. (30 TRIPS) $ 46,080
16 COST PER LINEAL FOOT - RIVETED SEAMS
17 COST PER LINEAL FOOT TO WELD
18 APPROXIMATE AMOUNT SAVED BY ELECTRIC WELDING
19 MR. HURLEYS PLANS FOR THIS YEAR CALL FOR 3,500,000 TONS
20 MR. HURLEYS PLANS FOR NEXT YEAR CALL FOR 7,000,000 TONS
21 SAVING IN COST BY ELECTRIC WELDING ?? MILLIONS
22 SAVING IN TIME AND EFFICIENCY BY ELECTRIC WELDING MILLIONS
23 THE RIVETED SEAM "DOES NOT" HARMONIZE WITH MODERN ENGINEERING PRACTICE ??
EXAMPLES OF DEFECTIVE WORKMANSHIP-RIVETED SEAM METHOD
(THE NAUTICAL GAZETTE)
A,B&D-ACTUAL DEFORMATIES IN RIVETED CONSTRUCTION.
B-NOTE LEAD FILLING IN BLIND HOLES
DEFECT IN C USUALLY RESULTS IN THE CONDITION SHOWN AT D.

Fig. 1—Comparison of Riveted Seam and Electric Welded Joint with Examples of Defective Workmanship.

value of electric welding in the construction and maintenance of railway equipment, and we expect to present in a future issue the application and use of the thermit and gas methods.

Earlier History of Welding

Electric welding by the antogenous process has only been successfully applied in modern times, although welding as an art no doubt dates farther back than most engineers or mechanics may think it has been practiced.

Electric welding was successfully accomplished in the United States by Elihu Thompson along about the year 1877, or 46 years ago. His system or method, however, is what is known as the pressure or butt welding process, and in reality is confined largely to a field unto itself. That the art of welding is one of the earliest discoveries of man seems to be supported by quotations from a number of very reliable authorities on the subject.

In the work of Dr. L. A. Groth, we find the following quotafourth Chapter of Genesis, I find that Tubal Cain (who lived about 3,950 years before Christ) is there described as an instructor of every artifice in brass and iron!"

So we may fairly conclude that the ordinary form of welding was known in those days; but to come down from the days of Tubal Cain to more modern times, it was the practice of several well-known firms in making iron boilers to weld the longitudinal seams of the shell plates instead of riveting them, and in 1874 some exhaustive tests then made proved the efficiency of these welded seams to be 70 per cent of the solid plate. The article by Dr. Groth, then described in detail repairs made to modern boilers, both by the oxy-acetylene and electric welding processes.

Baldwin Locomotive Works Leaders in Electric Welding

Among those who first recognized the great value of electric welding in the construction of locomotives was the Baldwin Locomotive Works of Philadelphia, whose business has grown from the little Ironsides of 1832 which had cylinders 9½x18 inches, steam pressure of 55 pounds and total weight of 11,000

*From Railway and Locomotive Engineering.

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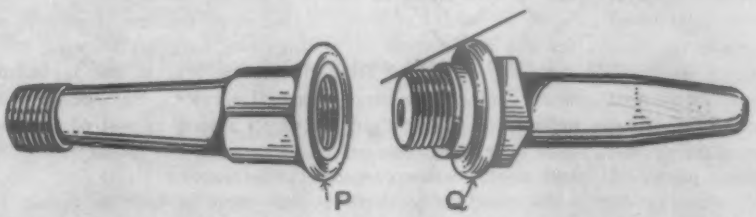

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pounds, to an annual output capacity of 2,000 engines, the volume of business measured in dollars having exceeding $123,000,000 in one of their most prosperous years.

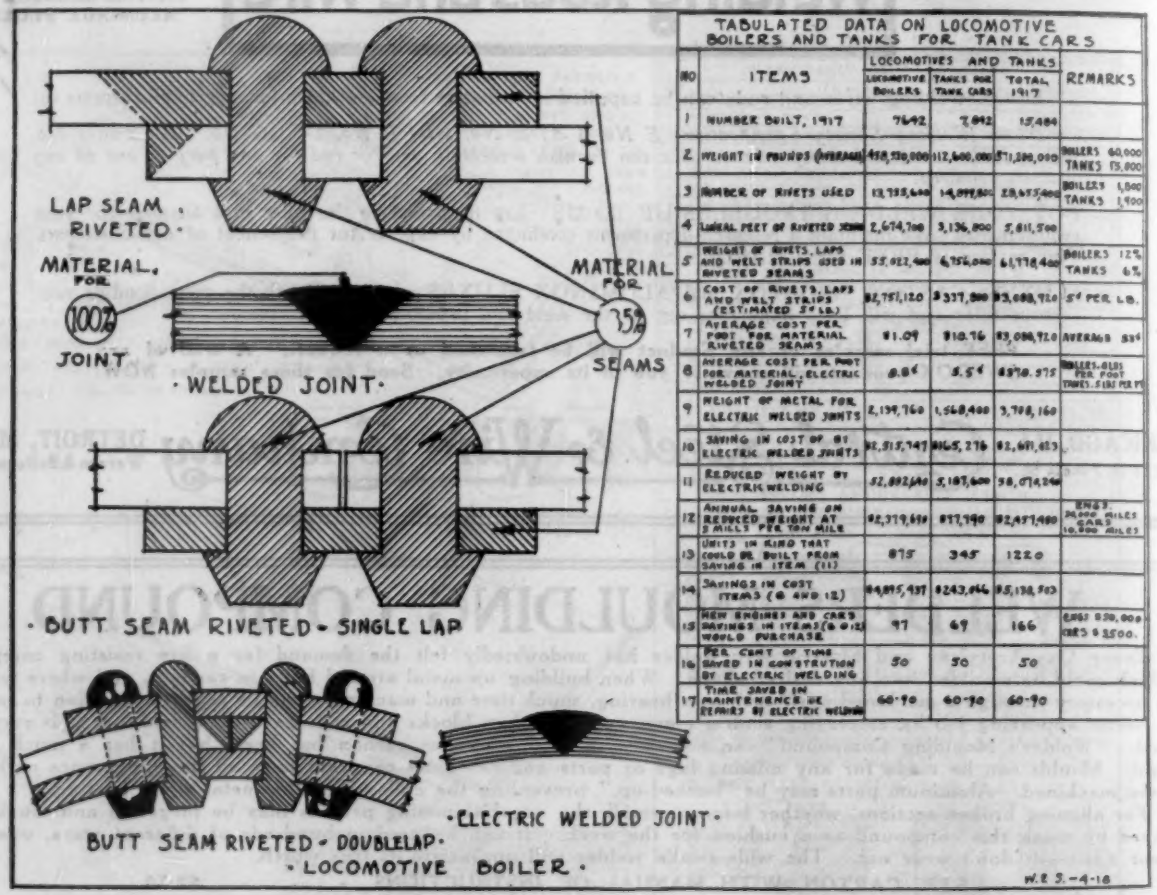
While some were theorizing on the application of electric welding in locomotive work, and others were using it in a more or less experimental or half-hearted way, the Baldwin people under the leadership of their aggressive president, Samual M. Vauclain went right to the heart of the subject and immediately produced results that have no doubt added materially to the profits of his company, and to the economic value of locomotives to their purchasers.

The system of electric welding in boiler construction had been so successfully standardized by the Baldwin people that they issued a booklet on the subject some time ago from which we quote the following:

The value of current to be used to obtain the best results depends largely on the thickness of the plates to be welded. In boiler and firebox work the welding current varies from 150 to 175 amperes.

Electric Welding in Locomotive Shops

Electric welding is now very generally used in the locomotive building and railway shops of the United States, and is recognized as a leading feature of economy. In boiler construction and repair it insures steam-tight joints at seams and tube ends, and in many cases it entirely eliminates riveted joints by substituting direct union between the edges of the sheets to be joined. This latter feature is particularly useful in the construction of fireboxes and combustion chambers where the joints are subjected to direct contact with flaming gases. Tube ends when welded to the firebox sheet can be kept tight under all service conditions.



TABULATED DATA ON LOCOMOTIVE BOILERS AND TANKS FOR TANK CARS

NO	ITEMS	LOCOMOTIVES AND TANKS: LOCOMOTIVE BOILERS	TANKS FOR TANK CARS	TOTAL, 1917	REMARKS
1	NUMBER BUILT, 1917	7692	7,842	15,484	
2	WEIGHT IN POUNDS (AVERAGE)	458,330,000	112,600,000	571,200,000	BOILERS 60,000 TANKS 15,000
3	NUMBER OF RIVETS USED	13,733,640	14,099,880	28,833,480	BOILERS 1,800 TANKS 1,900
4	LINEAL FEET OF RIVETED SEAMS	2,674,700	3,136,800	5,811,500	
5	WEIGHT OF RIVETS, LAPS AND WELT STRIPS USED IN RIVETED SEAMS	55,022,400	6,756,000	61,778,400	BOILERS 12% TANKS 6%
6	COST OF RIVETS, LAPS AND WELT STRIPS (ESTIMATED 5¢ LB.)	$2,751,120	$337,800	$3,088,920	5¢ PER LB.
7	AVERAGE COST PER FOOT FOR MATERIAL RIVETED SEAMS	$1.09	$10.76	$3,088,920	AVERAGE 53¢
8	AVERAGE COST PER FOOT FOR MATERIAL, ELECTRIC WELDED JOINT	0.84	5.54	$970.975	BOILERS-81.05 PER FOOT TANKS-5.181 PER FT
9	WEIGHT OF METAL FOR ELECTRIC WELDED JOINTS	2,139,760	1,568,400	3,708,160	
10	SAVING IN COST OF BY ELECTRIC WELDED JOINTS	$2,515,747	$165,276	$2,681,023	
11	REDUCED WEIGHT BY ELECTRIC WELDING	52,892,640	5,187,600	58,074,240	
12	ANNUAL SAVING ON REDUCED WEIGHT AT 3 MILLS PER TON MILE	$2,379,659	$17,190	$2,497,489	ENGS 24,000 MILES CARS 10,000 MILES
13	UNITS IN KIND THAT COULD BE BUILT FROM SAVING IN ITEM (11)	875	345	1220	
14	SAVINGS IN COST ITEMS (6 AND 12)	$4,895,437	$243,066	$5,138,503	
15	NEW ENGINES AND CARS SAVINGS IN ITEMS (6 & 12) WOULD PURCHASE	97	69	166	ENGS $50,000 CARS $3500.
16	PER CENT OF TIME SAVED IN CONSTRUTION BY ELECTRIC WELDING	50	50	50	
17	TIME SAVED IN MAINTENANCE OR REPAIRS BY ELECTRIC WELDING	60-90	60-90	60-90	

Fig. 2—Comparison of Riveted Seams and Welded Joints with Tabulated Data.

"Electric arc welding is the transformation of electrical energy into heat through the medium of an arc for the purpose of melting and fusing together two metals. The metal to be welded is made one terminal of the circuit, and other terminal being the electrode. By bringing the electrode into contact with the metal and instantly withdrawing it about ⅛ inch, an arc is established between the two. As more heat is generated at the positive than at the negative terminal, the work to be welded is made positive."

The metallic electrode is used almost exclusively in locomotive work, the carbon electrode being used only for burning the sand out of the holes in steel castings, preparatory to burning out such holes with a metallic electrode, and for cutting purposes. The metallic electrode should be a mild steel wire showing on analysis about 0.18 per cent carbon, manganese not exceeding 0.5 per cent and with only a trace of phosphorus, sulphur and silicon.

It is very desirable that a short arc be used in welding in order that the metal being carried from the electrode to the work shall not be oxidized and thus produce a porous weld. In order to produce a short arc, the voltage across the arc should be from 20 to 30 volts, depending on the amount of current required.

The methods of welding boiler joints are now so well established that positive results are assured as the process is entirely beyond the experimental stage. Illustrations of these operations are photographic records of actual accomplishments, and as such are representative of the progress of the art.

An important economy is found in the use of electric welding for the reclamation of castings and forgings showing minor defects or variations from dimension, and in the replacement of worn surfaces on parts in actual service. Salvage of this character means more than the direct saving in cost of material: the gain over time required for complete replacement is frequently a factor of greater economic importance.

Locomotives to earn revenue must be kept as far as possible in continuous service, long delays in the repair shop must be avoided. By the use of electric welding many repairs are made possible without complete dismantling or complete withdrawal from service: the revenue-earning value of the locomotive is thus considerably increased.

The work that can be accomplished by electric welding covers so great and various a field that the scope of this article can

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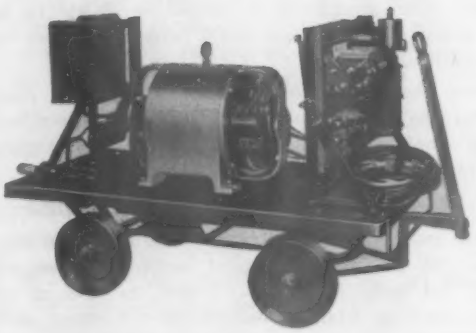
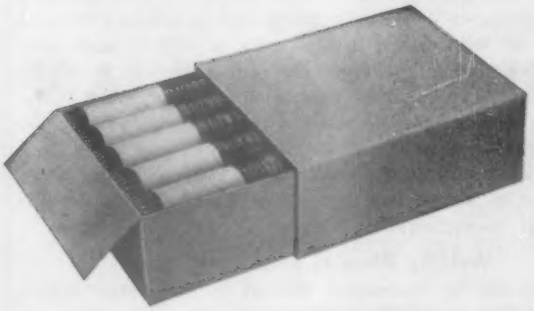
Steel
Brass
Bronze
Monel Metal





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cover only a few of the usual operations. These are set forth by description, illustration and under detail headings:

Patching Flue Sheets

Cracked, warped and mud-burned flue sheets in condition formerly requiring complete replacement are now readily repaired by electric welding and without removal from the boiler. The damaged portion is cut out and a sufficient number of flues removed to allow the welding operator room to work on the inside as well as the outside of the sheet. A patch of new plate is clamped into the opening made by the removal of the damaged portion. A clearance of 1/8 inch to 1/8 inch is allowed between the edges to be welded, and in this space a weld is made with the metallic electrode, first from one side and then from the other until a perfect union of the metal is accomplished. The patched sheet is then redrilled and the tubes refitted, making the locomotive again ready for service without the long delay incident to applying an entirely new sheet. If desired, the flues themselves can be welded into the flue sheet according to the following general instructions:

Welding Flues to Flue Sheet

All flues should be thoroughly cleaned by sand blast before welding. Old flues should be reset with standard expanding and beading tools.

In preparing new flues and newly pieced flues for welding, the sheet should be cleaned thoroughly by sand blast after the flues have been expanded and before the flues are beaded. After the sheet is cleaned, the flues should be beaded without the use of oil or any other kind of lubricant.

The welding operator should be held responsible for the sheets being perfectly cleaned before starting to weld.

Welding should be done with the boiler filled with water. All flues should be made perfectly tight before the welding is attempted. In case of new flues and newly pieced flues, the water should be put in the boiler after the flues have been expanded, and they should be made tight before they are beaded. All the superheater flues should be welded first, starting with the top row. The remaining flues should be welded by starting at the top row and working downward. Each flue should be welded by starting at the bottom and welding up on one side and then on the other, completing the weld at the top of the flue.

Welding one flue forms a deposit on the adjacent flue beads and sheet: before starting to weld one of these adjacent flues, all such deposits must be removed with a wire brush.

While welding, the work should be watched very carefully by the operator, so that if there is any indication of improper fusing of the metal, it can be cut off immediately and rewelded.

Flues should be welded with 1/8-inch wire.

After welding, the joint should be tested by a hydrostatic pressure of 25 per cent in excess of the boiler pressure. If there is any leakage, the weld should be cut off and the flue reset and rewelded.

Boiler Repairs to Locomotives in Service

When removing welded flues, the old weld should be cut off and the sheet carefully prepared for the new flue. Rolling, expanding and beading should be done by standard methods, after which the flue should be welded in and tested. If no welding machine is available at the point of repairs, the engine can be placed in service after the new tube has been set and beaded in the ordinary manner, the final operation of welding being left to the first opportunity.

When welding cracks that occur between stay-bolts the bolts should first be removed and the cracks chipped clean with a diamond-point chisel. After welding is accomplished, the stay holes must be retapped and new stay-bolts applied in the usual manner.

Boiler check joints and other similar ground joints that have become so cut and pitted that they can no longer be ground to a surface can be readily repaired by welding. The bad spots can be cut out with a diamond-point chisel, the metal cleaned and a new surface built up for regrinding.

Training an Operator

Training an operator usually requires comparatively short time, as any man of average intelligence can become a skilled operator in from three to six weeks of conscientious practice. The first exercise consists of welding together scrap pieces of metal to learn the correct manner of holding the electrode to form a proper arc between it and the metal to be welded.

When practicing flue welding, the operator should use a short piece of tube or a piece of sheet metal rolled to represent a flue. This can be inserted into a piece of plate representing the flue sheet. The importance of cleanliness should be impressed on the beginner: without clean metal perfect welds are impossible of accomplishment.

Following the proper instructions, the operator readily perceives that the welding of boiler seams and flues is a comparatively simple process, and with confidence once gained, soon becomes expert in the art.

Welding Cast Iron—Electric Arc Method

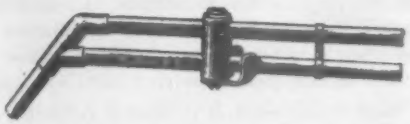
Doubtless most of our readers, who are interested in this subject know of the great value of welding broken locomotive cylinders, and quite a few may recall the use of and great economies resulting from its use on the restoration of damaged German ships in American ports during the late war, and even though this may not be news to some of our readers, we feel that a review of the repairs made on damaged cylinders will be quite interesting to those who specialize in locomotive work.

The Germans have made great strides in the arts and sciences, particularly so in scientific investigation in nearly all branches of engineering subjects and great credit is due them for what they have contributed to the engineering world; and we might add that Dr. Goldsmith, who discovered and developed thermit welding, is entitled to special recognition on that score.

In this particlar case, however, the Germans did not reckon with the resourcefulness of the American engineer and mechanic. They also shared in the belief, still held by what is becoming more and more of a minority among the American engineers and mechanics, that cast iron could not be welded. Therefore, when they received instructions from Berlin to damage the machinery of their ships they selected the parts which they believed could not be restored either by engineering science or Yankee ingenuity, as was evidenced by the destruction of something like one hundred and eighteen essential parts of steam cylinders of the interned ships in the New York harbor.

These engine cylinders were restored under the supervision of the Navy Department of the United States Government, more than eighty major breaks being successfully repaired by the electric welding process, the work being done in about one-tenth the time and at about one-quarter the expense ordinarily required by other methods, the saving effected amounting to many hundreds of thousands of dollars. The best evidence that can be offered as to the satisfactory manner in which this work was completed would be to quote from the report of Commander Jessup, under whose direction the repairs were made.

"Scleroscopic investigation of the structure of the welds shows only a very slight vein of hard cast iron at the line of weld, shot through with fingers of gray cast iron, while behind this area there was no heat effect whatever. The metal thus deposited was easily workable with hammer and chisel, file or cutting tool. Another very important feature is that by the use of low voltage and absolute automatic current control there is a minimum of heat transmitted to the parts to be welded, this being practically limited to a heat value absolutely necessary to bring the electrode and the face of the metal to be welded into a semi-plastic state, thus insuring a perfect physical union, and in accomplishing this result neither of the metals suffers from excessive heat, and there is absolutely no necessity for preheating. Neither are there any adverse results from shrinkage, following the completed work owing to a minimum amount of heat being transmitted to the repair parts, thus avoiding the possibility of distortion of parts through uneven or excessive shrinkage strains that are very com-



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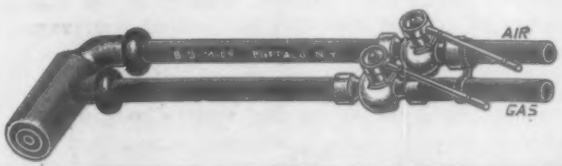

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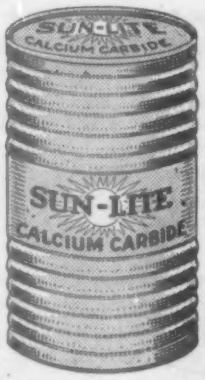

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mon where preheating is necessary or excessive heat is used for fusing metals."

From the foregoing it must be clear to any who might have been of doubtful mind, that the welding of these damaged cylinders was not only an important factor in winning the war, but saved many hundreds of thousands of dollars, and that electric arc welding played an important part in the field of marine engineering.

Element of Doubt in Riveted Joints

To those who may still feel some degree of reluctance in extending the use of electric welding to boiler construction or repairs, and who may hold to the rather general belief of some time ago, that welded joints had hidden defects, while riveted joints were practically free therefrom, we would invite attention to some rather striking and what we consider very convincing examples favorable to the welded joint. The Figs. 1 and 2 show a comparison of riveted and electric welded joints. In Fig. 1, actual examples of defects in the former method are shown, and comparison of the two methods in locomotive boiler construction is shown in Fig. 2.

Comparison of Riveted Seam and Electric Welded Joint

Fig. 1 shows first, plate 5x20 feet such as is ordinarily used in steel ship construction after it has passed through the operation of a punching machine, that punches 4,000 holes per day. In this particular instance there has been punched in this sheet 672 holes, the weight of the punchings being about 135 pounds; next below is shown a plate of the same size which has been prepared for the electric welding process. Between the two plates may be seen a typical butt joint riveted seam such as is commonly used in ship construction, while below is shown an electric welded joint.

The methods followed in the preparation of the first sheet and the assembly of the upper seam produces what is called an 85 per cent riveted butt joint seam, while the lower one produces a 100 per cent welded joint.

The tabulated data at the right of Fig. 1 gives some salient points of interest.

In a ship of five thousand tons for example, we find there are used in its construction 450,000 rivets and that there are approximately 70,000 lineal feet of joint or seam. The weight of steel used in a ship of this size is 3,600,000 pounds; and assuming that the weight of metal used in laps, rivets, welts, etc., essential to the riveted seam at 8 per cent, then the amount of metal for this purpose would be 114 tons or 288,000 pounds. At 5 cents per pound, this metal would be worth over $14,000. Increased cargo space would result from the elimination of a large majority of these riveted seams and the substitution therefor of electric welding would have a money value that should attract the attention of all efficiency engineers or managers. In a word, the riveted seam does not in all cases harmonize with modern engineering practices.

Examples of Defective Workmanship, Riveted Seam Method

Attention is invited to examples Fig. 1, A, B, C and D of defective workmanship in the construction of ships or other similar structures where the riveted seam method is employed.

Example B shows where lead filling was applied, where the holes in the two sheets did not come even. In the particular case in question a ship was built by a concern in England, and after it had been in service a year or so it was brought in for certain repairs and while standing at the dock or wharf the building adjacent thereto was destroyed by fire, the flames reaching across and burning the woodwork of the ship and all of the paint from the sides of the plates. After the fire was extinguished, it was noticed that the ship was striped all over its sides next to the wharf with vertical stripes. Upon examination, it was found that these stripes were from melted lead with which the holes had been plugged up on the sides of the ship in its construction by riveters who found it easier to follow this method than to re-ream the holes and apply the rivets as they should be.

To those who stick to the riveted seam for all purposes, and reject a welded joint on the grounds that it might be defective, this should serve as a striking object lesson.

Comparison of Riveted Seams and Welded Joints

Fig. 2 shows very clearly an amount of superfluous, or what may be termed, unnecessary metal in the production of an 85 per cent riveted seam as compared to what is necessary in producing a 100 per cent welded joint.

The top view shows what is ordinarily termed a lap seam, the second view a welded joint, and the third view a butt joint riveted seam; the fourth view to the left being a butt joint riveted seam, with double welt strips inside and outside; while to the right of this double welt seam is another electric welded butt joint.

Referring to the tabulated data, it may be observed that in 1917 there were built in the United States a total of 15,484 locomotive boilers and tanks combined. Placing the weight of these boilers at 60,000 pounds, and tanks at 15,000, the combined weight is 571,200,000 pounds. There were used in their construction approximately 28,655,000 rivets and if the percentage of metal necessary in a riveted seam is as much as 12 per cent in locomotive boilers, and 6 per cent in tanks, then the weight of extra metal necessary for these riveted seams amounts to over 61,000,000 pounds, and at 5 cents per pound, would cost more than $3,000,000.

Based on the above estimate as to the amount of metal required in riveted seams, this would be equal to the weight of 875 locomotive boilers and 345 tanks, or a total of 1,220 units. The field is certainly an inviting one to those interested in modern efficiency methods.

The purpose of the foregoing is not to cast discredit on good mechanically honest riveted seams or joints, but to emphasize the fact that riveted joints that look 100 per cent to the eye are sometimes dangerously defective, while from the standpoint of quantity of material used they are certainly extravagant to the point of actual waste when compared to welded joints.

Electric Engineering

Engineering in its last or final analysis consists of the application of nature's forces to the uses of man, and he that can best adapt these forces to produce the greatest good to the greatest number is by this same standard the greatest engineer.

Electricity in itself is not the product of inventive genius, but the result of discovery, it being one of nature's forces that a Divine Providence provided for man and which lay, slumbering as it were, in nature's great storehouse ages and ages awaiting man's advancement in the fullness of time to a higher plane when he only had to simply tap this great source of power and take therefrom without money or price.

All of the natural elements were in existence when Adam and Eve were in the garden of Eden, and a few thousand years later in the time of King Solomon and Julius Caesar, for them to have had telephones, electric bells, telegraph lines, automobiles, aeroplanes, electric trucks, electric railways and electric welding, but man had not yet developed to a point where these forces were essential to his existence or prosperity.

The answer, or reason for this, however, is quite clear when we reflect that the great transportation chiefs of that period amassed great fortunes, lived in luxury, gave the public all they wanted in the way of safe, and what they termed swift transportation, at a satisfactory rate and were able to operate with prime movers that cost from only a few dollars to as low as about 2 cents each, while the compensation of employes was less than 15 cents per day, that of many being less than 1 cent per day. Manifestly there was no incentive or necessity to seek means of increasing net earnings from operations, or attaining greater speed.

It has long been known to engineers and also to mechanics, particularly the blacksmith and boiler maker, that there is a critical heat to all metals at which they may or may not be safely worked and this is particularly true as to steel, in fact it is still a watch word or slogan among the boiler-making fraternity, to be sure and never attempt to flange a steel sheet or plate at the "dangerous blue heat." This is a danger signal which stands as a warning before the eyes of every boilermaker from the time he takes up his occupation or profession until he ceases to follow it. The blacksmith is also trained in a similar way with respect to the critical heat at which metals can be properly

welded, and above everything else he has always been guarded against burning it or attempting to weld at a too low temperature, yet in view of all of these facts and the additional information which comes to the users of electric welding through experience, many continue to restore parts that are beyond repair and should be replaced with new material, consequently it is not strange that there are failures, which have a tendency to discourage the further introduction of the art. All of these features are, however, of easy solution.

In summing up we wish to again refer to certain fundamentals essential to success.

First: Any weldable metal can be welded with a system which employs proper heat values and proper current control together with a welding metal suitable for the work, and a competent welder.

Second: With too high voltage, lack of current control, poor operator and general run of electrodes, simply called good iron, welds, made will abound with such defects as voids, craters, slag pockets and lumps crystalline in character, all or any of which render the weld defective.

Third: Do not attempt impossible or unmechanical things no matter what kind or type of welding system is involved, for failure is sure to follow; and finally:

If any there be who feel that they have a monopoly of either welding or cutting, and have completely covered the field to the exclusion of all others, we beg to remind them of the fact that when Alexander the Great sat down and wept that there were "no more worlds to conquer," he had only just scratched a little around the edges of the habitations of man.

NESS SPOT WELDING MACHINE

The H. J. Ness Mfg. Co., 305 Broadway, New York City, has recently announced a new type of electric spot welder, designed for operation on alternating current or adapted to the use of direct current by the means of a special device provided for this purpose.

Location of the transformer is within 2 in. of the rear ends of the two horns, and midway between them, is one of the special features of this machine. It is claimed that by placing the transformer close to the electrodes the efficiency of the welder is increased since the current losses are lessened. It is also pointed out that an approximately uniform heat in the electrodes is obtained from making both leads about the same length. The standard machine will hold 30 gauge wire to 1/4 in. rod with a 10 amp. fuse in the circuit. Sparking at this point is practically eliminated by using an oil dash-pot switch which makes for a longer life of the switch points, and reduces the lag between the switch and the electrodes.

News of the Welding Trade

Harold S. Card, Associate Editor of *The Welding Engineer*, is the proud father of a fine girl. Harold is doing well.

E. S. Hurd, Chicago district manager for the Gibb Instrument Co., has been enjoying a long vacation on the coast of Maine, and is now back on the job.

It is planned to hold the first meeting of the American Welding Society, Chicago Section, on Friday evening, October 5th. Announcement of the program of the first fall meeting will soon be mailed to all Chicago members, and to others who are interested in the affairs of the society.

M. Keith Dunham has recently returned to his office in Chicago after a month's vacation trip in the northwest.

The fall meeting of the American Welding Society is to to be held in Pittsburgh during the week of October 24th to 28th. Complete details of the program are not yet available, but it is thought that there will be some very interesting sessions.

The Wire and Cable Works of the John A. Roebling Sons Co., Trenton, N. J., is to be enlarged by the addition of a new one story power house at Clinton Ave.

W. J. Haywood is president of the Yale Welding Works, 487 Grand Ave., New Haven, Conn., which has been formed to do electric and oxy-acetylene welding and cutting.

E. L. Mills, sales manager of the Bastian-Blessing Co., when last seen was headed for the northwest carrying a high power bear gun, and accompanied by all the fox-terriers he could capture in his neighborhood. He has promised the Chicago Section of the American Welding Society a barbecue if he bags a bear.

A recent visitor among the Chicago trade was Mr. John A. Dittmar, president of the Southern Welding & Machine Co., San Antonio, Texas.

W. A. Slack, president of the Torchweld Equipment Co., is a proud possessor of a new Hudson coach. He recently made a long trip to Indiana without accident, except that his new fenders were terribly dusty when he finished the return trip.

Mr. W. L. Harris, of Mackey & Harris, Los Angeles, Calif., is spending a couple of weeks in Chicago this month arranging for distribution in the middle west of the Nigg Bros. Electric Arc Welder.

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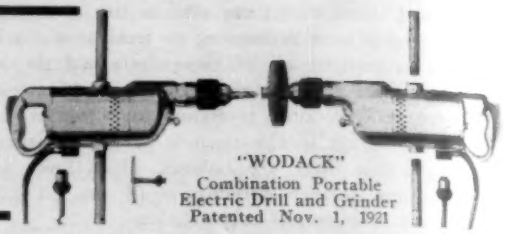

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CURRENT WELDING LITERATURE

FLAME MAKING AND REPAIRING—Papers on the practices followed in flame making and repairing on the Boston & Maine Railroad, the Central Railroad of New Jersey and the Delaware, Lackawanna, Western Railroad. The procedure followed in these various shops is described and illustrated.—Railway Mechanical Engineer, September.

THE OXYGEN-HYDROGEN DIGEST—Bulletin published from time to time by the Gas Products Association, and mailed to users of oxygen and hydrogen. No. 1 contains digests of papers on such subjects as safety, service and new uses for welding processes.

OXY-ACETYLENE TIPS—Monthly publication of the Linde Air Products Co., New York City. The August issue contains the following collection of welding stories: Welding Blast Engine Cylinder Saves Six Weeks' Delay—Imperfect Castings Once Scrapped Are Now Reclaimed.—Copper Expansion Joints in Large Dam are Oxy-Acetylene Welded—All Welded Mobile Kettles—Tests Certify Quality of Welded Ammonia Piping—A New Field for Oxy-Acetylene Welding—The Meaning of Service to a Rubber Company—An Example of Service—Oxy-Acetylene Welding in Boiler Shop—Slotting Pipe by Oxy-Acetylene Cutting.

WELDING MANGANESE STEEL TO ORDINARY RAILS—Description of an experiment made to see if switches and crossings can be made by depositing manganese steel on rails made of ordinary steel and grooved to receive the deposit of the metal. A coated wire containing nearly 14% manganese and slightly over 1% carbon was used. Three thin layers were deposited to make the total pad of added metal ⅝ in. thick. The experiment shows that there is a thin layer of martensite which cannot be avoided. Special methods which would result in giving the deposit a mechanical grip on rails recommended.—Revue de Metallurgie, July.

OIL OXYGEN EXPLOSIONS—Emphasizing the danger of producing a combination of oxygen and oil or greasy matter. Several examples are given of accidents which were due to substituting oxygen for compressed air.—Acetylene et Soudure Autogene, June.

OXYGEN—The story of the manufacture of oxygen by the process of liquefying air, going back to the first attempt to secure oxygen this way and comparing the various types of apparatus which have been perfected for the process.—Autogene Metallbearbeitung, May.

AN INVESTIGATION OF AUTOGENOUS WELDING, by M. Piette—Speed of welding and the rate of gas consumption—remarks on the preparation of the pieces and the execution of the welds—selecting the torch for the job—selecting the filler rod—strengthening welds—factors to be taken into account when classifying welds.—Revue de la Soudure Autogene—July and August.

WELDING, CUTTING AND BRAZING PRACTICE, by David Baxter—Cylinder block welding jobs require varied degrees of skill and care, and in every case success is dependent upon the one fundamental principle of expansion and contraction of all metal when heated and cooled. Treatment of the subject is very elementary, but it gives the garage mechanic knowledge of the various important things which are to be observed if the block is to be restored exactly right.—American Garage and Auto Dealer, August.

SPEED VERSUS GOOD WELDING, by R. G. Mason—Stressing the importance of doing a good job rather than doing a quick job. The use of too much heat in welding is poor economy, because it results in discomfort for the operator, too heavy a flame on the metal, probably burning of the metal and unnecessary gas consumption. There are many difficulties which can result from trying to rush a weld.—Journal of the A. W. S., August.

WELDING OVERHEAD WITH THE OXY-ACETYLENE FLAME, by C. J. Nyquist.—The author expresses the opinion that certain classes of steel welding demand more real welding ability and personal dependability than any other class of metal welding. Overhead work requires thorough knowledge of heat distribution and spread of welding material. Utmost care must be used in the handling of the welding rod. The idea that molten metal must be blown on and driven into base metal is wrong. Better work is done with the soft flame. Forcing the weld forward results in overlapping and adhesion.—Journal of the A. W. S., August.

WELDING SMALL TANKS BY THE OXY-ACETYLENE PROCESS—Common designs for tank joints to meet various conditions. Necessity of penetration to the complete depth of the seam, and complete fusion of the metal for the entire thickness. Designs and directions for several types of small tanks to be built by oxy-acetylene welding. Handy tables for figuring dimensions.—Acetylene Journal, September.

TAKING THE TORCH TO THE JOB, by David Baxter—The ease with which the shop owner may enlarge his activities and, incidentally, his practice, by doing repair work in the field or on the premises of the customers.—American Blacksmith & Motor Shop, August.

E. L. Wilson Hardware Company, 249 to 263 Liberty Avenue, Beaumont, Texas, manufacturers of shelf and heavy hardware, oil well, mill and refinery supplies wishes to receive catalogs covering various lines of welding apparatus.

A new warehouse has been established by The Linde Air Products Company at the B. & M. Wharf, Portland, Maine, in order to give service to users of Linde Oxygen and Prest-O-Lite Acetylene in the state of Maine. A. W. Jordan, 11 Exchange Street, will be in charge of distribution.

The American Welding Industry is at present very well represented in England by the following prominent men in the industry: A. Cressey Morrison, A. F. Jenkins, Lorn Campbell, Lorn Campbell, Jr. and F. M. Morehead. This information was received on a card from Lorn Campbell, Jr., who states, "London is a mecca for Yankees."

It is reported that the appropriation of the Union Carbide & Carbon Corp., New York City, after increasing its plant equipment in different parts of the country, is in excess of $5,000,000. This includes the cost of erecting several new oxygen producing plants by the Linde Air Products Co. division.

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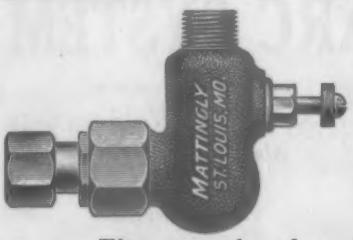

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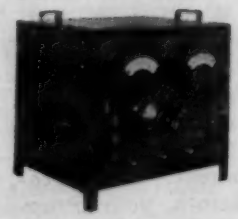
QUASI-ARC SYSTEM

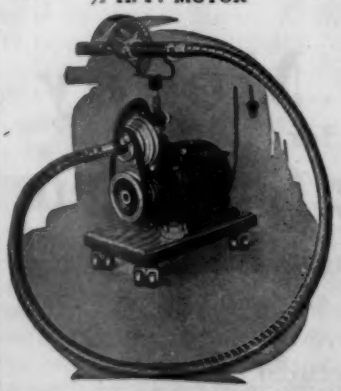


L. W. 110 V. WELDER

We Manufacture:
A. C. & D. C. Welding Sets
Also Weldtrodes for
Mild Steel
High Carbon
Manganese
Cast Iron
Gives Machinable Weld

QUASI-ARC WELDTRODE CO., INC.
Peekskill, New York

YTPEM6
½ H. P. MOTOR



Strand
Trade Mark

GRIND Those Welds With
STRAND
Flexible Shaft Grinders
Thousands in Use

N. A. Strand Co.
CHICAGO
5001-5009 North Lincoln St.

Westinghouse
manufactures complete arc welding equipment for all welding and cutting purposes. Write for Leaflet 1826-B which describes this equipment in detail.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

No. 511
Welder's Spectacle
Manufactured by
Chicago Eye Shield Co.
2300 Warren Ave. Chicago

IMPERIAL WELDING AND CUTTING EQUIPMENT
OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch—are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 817 S. Racine Ave., Chicago

DAVIS-BOURNONVILLE COMPANY
was merged with
AIR REDUCTION SALES COMPANY
on March 17, 1922

The Oxyacetylene Welding and Cutting products formerly manufactured by Davis-Bournonville Co. are now made and sold by Air Reduction Sales Co. under the trade name of "Airco-Davis-Bournonville" or "Airco-D-B."

(See advertisement of Air Reduction Sales Co.)

Carbic

Safe, Portable,

Acetylene—at a Lower Cost

With the Carbic generator you do not even need a truck. It weighs only 200 lbs. when charged.

Can be moved anywhere with ease and absolute safety. The Fire Underwriters' list Carbic as standard.

It will handle the big jobs as well as the small, and it is economical, for acetylene from Carbic cake costs but one-half as much as compressed acetylene, and there is no returning of cylinders.

In addition to these essentials, Carbic has many other distinct advantages. Let us tell you more about the Carbic System for **your** work.

A cake of Carbic as taken from the drum —convenient and clean.

A partly used cake of Carbic. "Good for another round."

The Carbic line is complete, including generators, torches, regulators and all other necessary apparatus and accessories.

Carbic Manufacturing Company

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ATLANTA, GA. 169 Haynes St.	CHARLOTTE, N. C. W. 9th St. & So. Ry.	KANSAS CITY, MO. 1411 St. Louis Ave.	EL PASO, TEX. 412 Myrtle Ave.
DENVER, COLO. Hendrie & Bolthoff M. & S. Co.	NEW ORLEANS, LA. Woodward, Wight & Co.	DALLAS, TEX. Briggs-Weaver Machinery Co.	

Warehouses and Representatives in other principal cities.

Carbic Cakes save money, time and patience, and yield a purer gas

MILBURN

COMBINATION TORCH
CUTS and WELDS
As effectively as separate torches

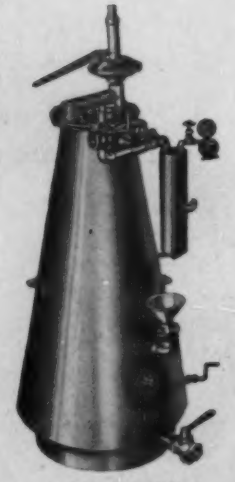
Cuts 24 inches thick
Welds heaviest jobs

YOU MERELY CHANGE THE TIP

SAVES
TOOLS
TIME
GAS

REGULATOR
OVERCOMES FAULTY PRESSURE
Facilitates Welding and Cutting

Built of Forged Bronze—Tensile Strength over 50,000 Pounds
The same Regulator for Welding and Cutting—and all Gases
Seats *with* instead of *against* pressure



30 lbs. CARBIDE PORTABLE GENERATOR
Automatically makes your acetylene gas at approximately 1c a cubic foot

Equivalent to 150 cubic foot cylinder of gas

Uses Commercial Carbide—procurable everywhere

Has no clock motor or gears

Steel body welded throughout
Weighs 200 pounds

A full line of apparatus.
Acetylene Generating and Compressor Plants.

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